Comparing LEDs vs. HPS lamps in Greenhouse Production of Seedlings

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Objective

Determine the effectiveness of lighting from light-emitting diodes (LEDs) and high-pressure sodium (HPS) lamps on growth and subsequent flowering of popular bedding plants.

Background

In early 2015, we installed LED toplighting from Philips in four sections of the Plant Science Research Greenhouses at MSU (right). In spring of 2015, we grew several different seedlings under one of four types of LEDs or under HPS lamps that delivered the same intensity of light. A sixth treatment delivered the same photoperiod but a much lower intensity. Plants under the five high light intensity treatments (LEDs and HPS lamps) generally had similar growth, and plants were generally of better quality than those under the low light intensity.

In this project, we modified some of the LED spectra to make the spectral quality of lighting treatments more different. One treatment included a newly developed LED array that emitted far-red light, which could increase the size of seedlings and also potentially accelerate flowering. In another treatment, the percentage of blue light was increased to determine whether that would reduce plant height.

Experimental Protocol

Geranium, pepper, petunia, snapdragon, and tomato were grown as seedlings, and after transplant, under each of six different greenhouse lighting treatments. Five of the six lighting treatments (#1 to 5 below) delivered 90 $\mu mol \cdot m^{-2} \cdot s^{-1}$ of photosynthetic light, while one treatment (#6) delivered 10 $\mu mol \cdot m^{-2} \cdot s^{-1}$. The lighting treatments were:

	Lamp type	Description
1	HPS	High-intensity control
2	R+B LED	B10 + R90
3	R+B LED	B45 + R55
4	R+W LED	B10 + G5 + R85
5	R+W+FR LED	B12 + G20 + R68 + FR
6	HPS	Low-intensity control

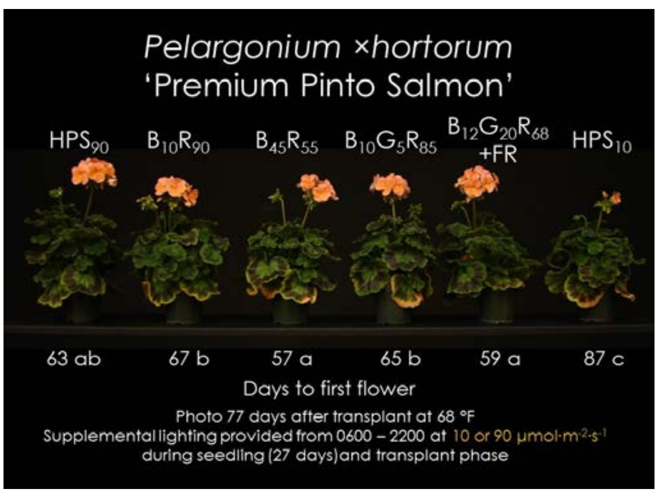
Where B= blue light (400 to 500 nm), G= green light (500 to 600 nm), R= red light (600 to 700 nm), and FR= far-red light (700 to 800 nm), expressed in percentages in the table above. The FR intensity delivered was 12 $\mu mol \cdot m^{-2} \cdot s^{-1}$. The air temperature was maintained at 68 °F and lights operated continuously for 16 hours per day. All of the LED fixtures were from Philips.

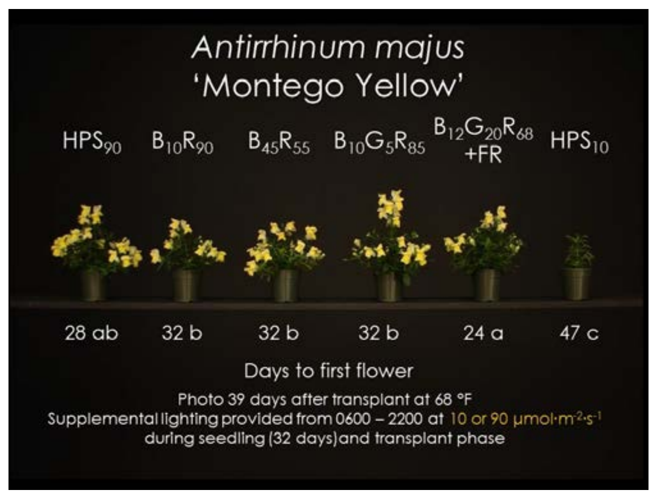
Data were collected on seedlings (leaf number, height, and root/shoot weight) and on finished plants (days to flower, height, and flower number).

Results

<u>Seedlings</u> – Plants were generally shorter under the HPS10 treatment than the higher-intensity light treatments because they were less developed (had fewer leaves). There were no consistent differences in height or leaf number among treatments #1 to 5, although snapdragon was tallest under treatment #5 (with FR light). Plants under the 5 high light intensity treatments had more root and shoot growth than under the low light intensity, but there were no consistent differences between those under HPS lamps or the LEDs.

<u>Flowering</u> – Flowering time was generally similar under the high-intensity light treatments (#1-5), and all flowered substantially earlier than under the low-intensity control. Geranium flowered 8 to 10 days earlier under the B45+R55 and B12+G20+R68+FR treatments than the others. Snapdragon also flowered earlier under the B12+G20+R68+FR treatment. Plant height at flowering under the high-light treatments was generally similar, although some plants were taller under the +FR treatment (#5) and shorter under the high blue light treatment (#3).





<u>Electrical consumption</u> – The reported efficacy of the two lamp types used in this study are:

400 W HPS lamps with magnetic ballasts: 0.9 µmol/J

190-200 W LEDs from Philips: 1.9 – 2.5 µmol/J

Therefore, the LEDs consumed 53% to 64% less energy than the HPS lamps to emit the same intensity of photosynthetic light. This improved efficiency and longer lifetime are the two major benefits of LED lighting.

Acknowledgements – This research w as supported by the Western Michigan Greenhouse Association and the Metropolitan Detroit Flower Growers Association, as well as the USDA. Seedlings were kindly provided by C. Raker & Sons and Philips subsidized the costs of the LED fixtures. We also thank Nate DuRussel for his technical support.