GROWERTALKS

Features

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Producing High-Quality Plugs

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Every grower has their own protocol or recipe for producing plugs and rooted cuttings that works best with their growing environment, resources and needs. However, there's always room for improvement.

In this four-part series, we'll highlight our most recent greenhouse photoperiodic and supplemental lighting research utilizing light-emitting diodes (LEDs) during the production of both plugs and liners. Lastly, we'll introduce you to the exciting possibilities that exist with indoor vertical production of young plants utilizing sole-source LED lighting and carbon dioxide (CO_2) injection.

Over the last decade, our research has quantified the influence of light quantity and quality during young plant production on numerous ornamental species. Our general recommendation for most young plants is to provide 70 to 90 μmol•m−2•s−1 of supplemental light to achieve a target daily light integral (DLI) of 10 to 12 mol•m−2•d−1. As a result, many growers are now producing young plants under supplemental lighting from high-pressure sodium (HPS) lamps, while others have made the investment in high-intensity LED fixtures (Figure 1A-D).

Most growers utilizing supplemental lighting report that production time is often reduced and that young plants are of higher quality (increased rooting, stem diameter and branching) and often flower earlier upon transplant. Additionally, when the ambient DLI is low (<7 mol•m−2•d−1) plugs of some species grown under LEDs providing ≥10% blue light are generally more compact (reduced leaf area and stem elongation), greener or have more pigmentation (anthocyanins) than those grown under HPS lamps or no supplemental lighting. Another group of growers use low-intensity LED photoperiodic lighting for 16 to 24 h•d−1 during young plant production and report reduced production time compared to no electric lighting (Figure 1E).

		Supplemental lighting				Photoperiod lighting			
	Control	HPS 16-h 70 μmol•m⁻²•s⁻¹	HPS threshold 90 μmol•m⁻²•s⁻¹	LED 16-h 70 μmol•m⁻²•s⁻¹	LED threshold 90 μmol•m⁻²•s⁻¹	Philips 16-h R:W:FR	Philips 16-h R:W	GE 16-h R:W:FR	GE 24-h R:W:FR
Total no. of hours of operation									
Nov.-Dec.	0	448	357	448	357	448	448	448	672
Jan.-Feb.	0	448	403	448	403	448	448	448	672
Feb.-Mar.	0	448	319	448	319	448	448	448	672
DLI (mol•m⁻²•d⁻¹)									
Nov.-Dec.	4.8	9.7	9.4	9.9	10.0	5.7	5.4	5.5	5.7
Jan.-Feb.	5.5	9.9	10.1	9.7	10.3	5.9	5.8	5.6	6.0
Feb.-Mar.	7.5	12.9	11.8	11.7	11.2	8.5	8.6	8.7	7.9

Table 1. The total hours of operation and daily light integral (DLI) for no electric lighting, threshold and 16-hour high-pressure sodium (HPS) and light-emitting diode (LED) supplemental lighting, and 16- and 24-hour photoperiodic lighting for the four-week study.

As the use of LED supplemental lighting increases, more questions surface. For example, since LEDs are much more energy-efficient to operate than HPS lamps, is there any benefit from running them continuously at a lower intensity even if the sun is out? Alternatively, is it more beneficial to run LEDs at a higher intensity in the morning, when it's cloudy and in the evening? There's value in addressing these questions, even though basic plant physiology tells us that plants can only utilize a certain quantity of light (light saturation point) for photosynthesis and anything beyond this is wasted energy.

Additionally, most commercially available LED fixtures only provide red and blue light, which can make plant observation a little more challenging, especially when it's dark. Therefore, we also wanted to determine how the addition of white light, mainly for human applications, would affect plug production.

Our objectives were to quantify plug quality and production time under 1) continuous 16-hour or instantaneous threshold supplemental lighting with HPS lamps or high-intensity LED top lighting; and 2) under low-intensity LED photoperiodic lighting with and without far-red light and compare these methods to plugs receiving no electric lighting.

The study

Seeds of Petunia x hybrida Ramblin' Peach Glow, Impatiens walleriana Accent Premium Salmon, Gerbera jamesonii Jaguar Deep Orange, wax begonia (Begonia semperflorens Bada Bing Scarlet) and tuberous begonia (Begonia x tuberosa Nonstop Rose Petticoat) were sown in 128-cell trays at a commercial greenhouse. One week later, trays were placed in a glass-glazed greenhouse at Michigan State University (MSU) in East Lansing, Michigan (lat. 40° N), with an air temperature set point of 72F (22C) and a vapor pressure deficit of 0.3 kPa maintained by injecting steam. Seedlings were hand irrigated as needed with reverse osmosis water supplemented with water-soluble fertilizer that provided 60 ppm nitrogen.

Plug trays were placed under each of nine lighting treatments that included a control (natural daylength with no electric lighting), four supplemental lighting treatments with either HPS or LED fixtures, and four photoperiodic treatments with LED lamps (Figure 2). Supplemental lighting treatments consisted of high-intensity 200-watt LED fixtures (Philips GP-TOPlight DRW-MB) providing a light ratio (%) of 10:5:85 blue:green:red (B:G:R) or 400-watt HPS lamps (P.L. Light Systems) providing a PPFD of 70 μmol•m−2•s−1 (on continuously for 16-h•d −1).

These same HPS lamps and LED fixtures were also used in instantaneous threshold supplemental lighting treatments (on from 6:00 to 8:00 a.m. and 5:00 to 10:00 p.m. and only on between 8:00 a.m. to 5:00 p.m. when outside PPFD was <185 μmol•m−2•s−1 and switched off when >370 μmol•m−2•s−1) providing a PPFD of 90 μmol•m−2•s−1.

Photoperiodic lighting treatments consisted of screw-in low intensity 14-watt LED lamps providing 2 μmol•m−2•s−1 of a light ratio (%) of 6:15:77:2 B:G:R:far-red (Philips GreenPower LED flowering DR:W) or screw-in low intensity 15-watt LED lamps providing 7:12:35:46 B:G:R:FR (DR:W:FR) for 16-h•d–1 or 10-W LEDs providing 3:17:48:32 B:G:R:FR (GE Arize Greenhouse Pro Photoperiodic LED Lamp) for 16 or 24-h•d –1.

Since our cntinuous supplemental lighting treatments (70 μmol•m−2•s−1) were on for 16-h•d–1 they operated a total of 448 or 672 hours during the four or six weeks of production, respectively (Table 1). In addition to sunlight, plugs under these treatments received an additional 5 mol•m−2•d−1 of supplemental lighting.

Figure 1. Supplemental lighting of young plants utilizing A) high-pressure sodium lamps, B-D) various commercially available high-intensity light emitting diode (LED) fixtures or E) LED photoperiodic lighting.

On the other hand, our threshold supplemental lighting at 90 μmol•m−2•s−1 provided 2.3 mol•m–2•d–1 as fixtures were on each day from 6:00 to 8:00 a.m. and 5:00 to 10:00 p.m. On very cloudy days, the lamps could potentially continue operating from 8:00 a.m. to 5:00 p.m. and provide an additional 4.2 mol•m–2•d–1 of supplemental light. During January and February, our threshold lamps ran for 403 hours and provided a very similar DLI during the four weeks of production (Table 1).

After four or six weeks (begonia only), plugs were subsequently transplanted into 4- or 4.5-in. pots filled with a commercial soilless media and finished in a greenhouse with an air temperature set point of 68F (20C) (petunia, begonia and impatiens) under the LED top lighting fixtures mentioned above or 72F (22C) under HPS lamps (gerbera).

Figure 2. A) Examples of high-pressure sodium (HPS), B) light-emitting diode (LED) Top lighting and C) photoperiod treatments (wire mesh was used to reduce light intensity).

Stay tuned for our second article in the four-part series where we'll share the results of our study looking at the effects of light quality, quantity and duration on plug production. **GT**

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