

GROWERTALKS

Features

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Understanding Light

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In commercial greenhouses, photoperiodic and supplemental lighting are two lighting strategies that can be used to help properly manage light levels throughout the day and seasonally. Some of the primary reasons why greenhouses manipulate light levels include temperature and irrigation management, to promote or inhibit flowering, and to optimize photosynthesis.

However, a recent survey found that 47% of greenhouse growers don't understand the difference between photoperiodic and supplemental lighting. To add to the confusion, the greenhouse industry uses a lot of jargon when referring to these two different lighting strategies. In this two-part series, we'll shed some light (pun intended) on the appropriate use of each lighting strategy. We'll begin by talking about supplemental lighting, which is sometimes referred to as "photosynthetic" or "assimilation" lighting. In next month's article, we'll discuss photoperiodic lighting.

Supplemental lighting

Supplemental lighting is used to increase the total quantity of photosynthetic light (or daily light integral; DLI) in a greenhouse by supplementing the natural sunlight received over the course of the day. In order to produce an acceptable quality floriculture crop, our general goal is to maintain a DLI of 10 to 12 mol·m⁻²·d⁻¹. If you're marketing higher-quality floriculture crops or vegetables such as tomatoes, then your goal should be to maintain a higher DLI. Of course, this varies from species to species. For more information on DLI, please visit

www.extension.purdue.edu/extmedia/HO/HO-238-W.pdf.

Due to greenhouse glazing, superstructure, shade cloth, hanging baskets, etc., DLIs above 30 mol·m⁻²·d⁻¹ are seldom achieved in commercial greenhouses from solar radiation (Figure 1). Over the past three and a half years, we've been recording the solar DLI in our unshaded double-poly greenhouse at Purdue University located in West Lafayette, Indiana. This DLI is represented by the green squares in Figure 1. From April to September, most growers use some sort of shading (in our greenhouses, we use automatic woven curtains that provide ≈50% shade) to modulate the temperature (red triangles), which can significantly reduce solar DLI below 10 to 12 mol·m⁻²·d⁻¹.

Supplemental lighting is most often used during the winter months (especially in northern latitudes) or overcast days when the amount of solar radiation reaching the greenhouse is insufficient to achieve a DLI of

10 to 12 mol·m⁻²·d⁻¹. High-value crops such as young plants (plugs and cutting liners), cut flowers, herbs and vegetables are most often placed under supplemental lighting (Figure 2) because increased growth and yield corresponds to greater revenue. Other benefits from increased DLI include more greenhouse turns for young plants due to shorter production times, plants that are compact, well-rooted and branched, and earlier flowering in the finished container. Growers that provide supplemental lighting to cut flowers, herbs and vegetables have increased yields and receive greater value per stem (cut flowers) due to increased stem length, flower size and larger fruits.

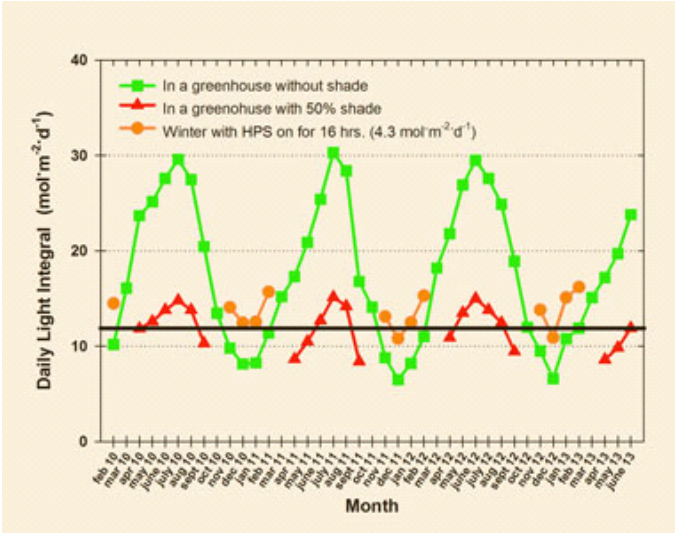


Figure 1. Daily light integral with or without shade and supplemental lighting in a greenhouse located in West Lafayette, Indiana.

In order to appreciably increase the DLI, a supplemental light intensity (typically 400 to 600 foot-candles or 50 to 75 $\mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$) from high-intensity discharge (HID) lamps, such as high-pressure sodium (HPS), metal halide (MH) lamps or light-emitting diodes (LEDs) are used. Table 1 gives some examples of how supplemental DLIs ranging from 1.4 to 9 mol·m⁻²·d⁻¹ may be achieved by using HPS lamps providing different instantaneous

light intensities (foot-candles or $\mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$) for different durations of operation time. In our scenario in Figure 1, from November to February, the DLI is below 10 to 12 mol·m⁻²·d⁻¹ in our greenhouse in West Lafayette and supplemental lighting is needed just to produce an acceptable quality floriculture crop. Therefore, on very overcast days, we use supplemental lighting from HPS lamps for 16 hours to supplement the solar DLI by 4 mol·m⁻²·d⁻¹ (orange circles).

Duration of light operation (hours)	Daily light integral (DLI; mol·m ⁻² ·d ⁻¹)				
	Supplemental light intensity (Foot-candles/ $\mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$)				
	250/33	400/52	500/65	600/78	800/104
12	1.4	2.3	2.8	3.4	4.5
15	1.8	2.8	3.5	4.2	5.6
18	2.1	3.4	4.2	5.1	6.7
21	2.5	3.9	4.9	5.9	7.9
24	2.8	4.5	5.6	6.7	9.0

Table 1. Cumulative amount of supplemental light (DLI) provided by high-pressure sodium lamps achieved by varying light intensities and durations.

We're often asked by growers, "How many hours should my HPS lamps be on to increase my DLI?"

The answer depends on many factors including: the amount of supplemental instantaneous light your lamps provide, the crops you're growing, the solar DLI reaching your crop, etc. In order to address some of these questions, we designed DLICALC (<http://extension.unh.edu/Agric/AGGHFL/dlicalc/index.cfm>). With DLICALC, growers can estimate the supplemental DLI from their supplemental light source and estimate the number of hours their lamps must be operated to achieve a target supplemental DLI.



Figure 2. Greenhouse supplemental lighting of herbs.

Most growers perceive supplemental lighting as too expensive without careful analysis of all economic factors involved. Installing and operating supplemental lighting systems can be expensive. However, crop growth, quality and yield are considerably higher during periods of the year when prices are generally much higher.

The successful use of a greenhouse supplemental lighting system requires: 1) careful design to ensure proper light intensity, distribution and uniformity; 2) monitoring light levels to ensure efficient use; and 3) proper equipment maintenance.

Young plants are often produced from December to March when the solar DLI in greenhouses can range from 1 to 12 mol·m⁻²·d⁻¹ in northern latitudes, thus requiring supplemental lighting (Figure 3a and b). Purdue and Michigan State University research recommends a target DLI of 10 to 12 mol·m⁻²·d⁻¹ for young plants. When the DLI is lower than this, uniformity, quality and timing can be negatively affected. For example, young plants may have delayed root and shoot growth, become elongated and weak. By providing a DLI of 10 to 12 mol·m⁻²·d⁻¹, time to produce a marketable liner or plug tray can be reduced by 25% to 50% depending on the species. **GT**

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