



Daily Light Integral Defined

The more you know about the light in your greenhouse, the more successful your growing operation will be.

By Erik Runkle

Daily light integral (DLI) isn't that friendly of a term. The units are cumbersome, and the value is not really easy to measure. However, the DLI has a profound impact on plant growth and development for essentially all greenhouse crops. Growers manipulate the DLI all the time, sometimes intentionally and sometimes unintentionally. This article explains what DLI is and what the values mean and then discusses why DLI is so important. In the December issue, I will discuss the different ways to measure or estimate DLI in your greenhouse.

What Is DLI?

The term "daily light integral" refers to the number of light particles, or photons, received during one day in a particular location and area. Photons that have a wavelength between 400 and 700 nanometers (nm) provide the energy for photosynthesis, which is the process of converting water and carbon dioxide into sugars and oxygen. These sugars are then used for plant growth. The DLI specifically refers to the amount of light received in 1 sq.m. of area, which equals 10.8 sq.ft. To sum it up, the DLI refers to the amount of photosynthetic light received in 1 sq.m. of area each day.

Conceptually, DLI is similar to the rain gauge in your backyard. A rain gauge is not used to measure the amount of rain per second or per minute but to measure the total amount of rain received in that particular location. If you empty your rain gauge every night, you can measure the total amount of rain received during a 24-hour period. Similarly, a light meter can be used to measure how many photons of light accumulate per square meter every day. The DLI cannot be measured instantaneously; a light meter must be used to measure how much light is received at least once every 10 minutes throughout the photoperiod to determine the average light intensity during the day.

DLI is measured in $\text{mol}\cdot\text{m}^{-2}\cdot\text{d}^{-1}$, which means the number of moles of light (mol) per square meter (m^2) per day (d^{-1}). What is a mole of light? A mole is a very large constant number (6.022×10^{23} , which equals 602,200,000,000,000,000,000). Therefore, 1 $\text{mol}\cdot\text{m}^{-2}\cdot\text{d}^{-1}$ means that 6.022×10^{23} photons of light struck 1 sq.m. of area during one day. This sounds like a very high value, but 1 $\text{mol}\cdot\text{m}^{-2}\cdot\text{d}^{-1}$ is a very low DLI for plant growth.

The maximum DLI we receive is about $60 \text{ mol}\cdot\text{m}^{-2}\cdot\text{d}^{-1}$ and occurs outdoors on a cloudless day in the summer when the photoperiod is long. The DLI outdoors may be less than $5 \text{ mol}\cdot\text{m}^{-2}\cdot\text{d}^{-1}$ in the winter on a dark, cloudy, short day in the northern part of the United States or Canada. Inside a greenhouse, the structure and glazing materials commonly reduce light transmission by 35-50 percent. Other obstructions, such as hanging baskets and heat pipes, further reduce the DLI. Therefore, the average DLI inside a greenhouse in the United States usually ranges from 5 to $30 \text{ mol}\cdot\text{m}^{-2}\cdot\text{d}^{-1}$.


DLI And Growing

What DLI is needed to grow high-quality transplants and finish plants? The answer depends on the crop, but a common target minimum DLI inside a greenhouse is $10\text{-}12 \text{ mol}\cdot\text{m}^{-2}\cdot\text{d}^{-1}$. Plant quality generally increases as the average DLI increases. In particular, as the DLI increases,

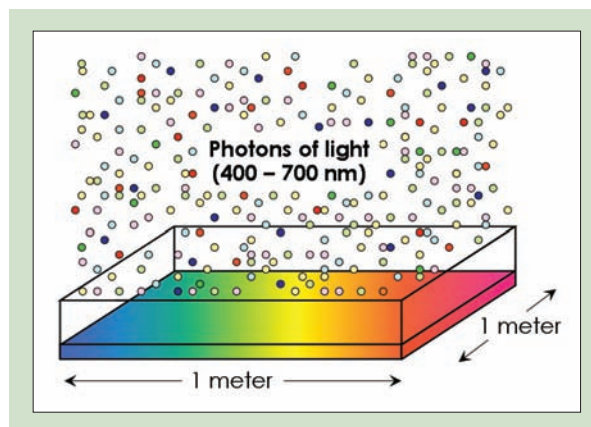
branching, rooting, stem thickness and flower number increase and sometimes plant height decreases. Some exceptions exist; shade crops such as African violets and phalaenopsis orchids grow well under an average DLI of $4\text{-}6 \text{ mol}\cdot\text{m}^{-2}\cdot\text{d}^{-1}$. In addition, some crops flower earlier when grown under a high DLI compared to a low DLI.

In the northern half of the United States, the average greenhouse DLI is below the target DLI of $10\text{-}12 \text{ mol}\cdot\text{m}^{-2}\cdot\text{d}^{-1}$ for about 3 months of the year. When the DLI is low outdoors, growers are wise to maximize the amount of natural

light that can reach their crops. For example, shading should be removed, the glazing should be clean and overhead hanging baskets should be kept to a minimum. The DLI can be increased by supplemental lighting from fixed high-pressure sodium lamps. In the South, the DLI is at or above this desired value during the winter, which provides a clear advantage to a southern location during the darkest period of the year.

For more information on DLI, check out the book *Lighting Up Profits*, edited by Paul Fisher and myself in 2004. It contains research-based information on lighting greenhouse crops. 

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