A greenhouse with potted hanging baskets suspended above a bedding plants crop often results in a sub-optimal daily light integral at bench height.

DLICALC Online Tool Helps Growers Calculate Daily Light Integral

Researchers have developed a new tool to help growers calculate supplemental daily light integrals and determine how much supplemental light is required to improve growth.

by **CHRISTOPHER J. CURREY, ROBERTO G. LOPEZ,** and **BRIAN A. KRUG**

MANAGING all the different environmental and cultural aspects of greenhouse crop production can be an intimidating and daunting task, especially during the peak production season. But it's necessary to produce a high-quality, salable plant. The greenhouse is full of moving targets, from root zone pH and EC to plant growth, air temperature and light. Managing each of the parameters of greenhouse crop production to consistently produce quality crops on time can be a challenge. Thankfully, the development of decision-support tools can aid greenhouse growers. GROCALC is a a suite of electronic decision support tools for growers that include ALKCALC, FERTCALC and PGRCALC. These programs are useful for making calculations related to greenhouse crop culture including water acidification requirements, fertilizer solution and plant growth regulator (PGR) mixing. However, there are few or no tools available to help make calculations related to the greenhouse light environment. Although light is frequently discussed in terms of instantaneous values such as the foot candle (f.c.) or micromole ($\mu mol \cdot m^{-2} \cdot s^{-1}$), the total photosynthetic light over the course of a day, known as the daily light integral or DLI, is becoming the preferred way to quantify light in a greenhouse. However, calculating DLI can be a daunting task. To continue the development of useful decision support tools, we created DLICALC (http://Extension.unh.edu/Agric/AGGHFL/dlicalc/index.cfm) as a tool to help growers manage the photosynthetic light environment.

DLICALC is the newest calculator in the GROCALC family of electronic decision-support tools for greenhouse growers interested in managing the daily light integral in their greenhouses.

A Solution For Growers

The inspiration for creating DLICALC came from growers' frequent questions about using supplemental lighting to increase the DLI. Some of the most frequently heard questions were, "How much photosynthetic light are my lamps contributing to the overall DLI in my greenhouse?" and "How long should I run my lamps if I want to increase the DLI by XX $mol \cdot m^{-2} \cdot d^{-1}$?" Since many growers still measure light in foot candles (f.c.) or, less often, micromoles ($\mu mol \cdot m^{-2} \cdot s^{-1}$), it is difficult to integrate those types of instantaneous light measurements into an integrated unit such as $mol \cdot m^{-2} \cdot d^{-1}$.

How DLICALC Works

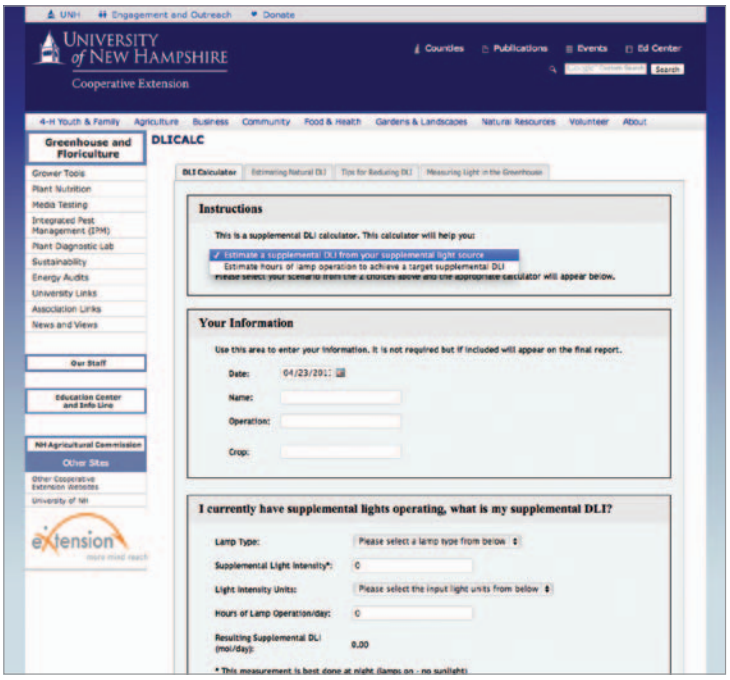
The main function of DLICALC is to calculate the answer to two different questions:

1 **"I currently have supplemental lights in my greenhouse. How long do I need to run them to achieve a target supplemental DLI?"** For example, a young plant grower has high-pressure sodium (HPS) lamps that provide 70 $\mu mol \cdot m^{-2} \cdot s^{-1}$ (530 f.c.) at plant height. They

would like to increase their DLI by approximately 4 mol·m^{-2}·d^{-1}, but are unsure how long to operate the lamps.

2 "I am currently operating supplemental lights. What is my supplemental DLI?" For instance, a bedding plant grower has metal halide (MH) lamps operating from 6 to 11 a.m. and from 5 to 10 p.m. (10 total hours of operation) providing 50 µmol·m^{-2}·s^{-1}, but would like to know how much of their total DLI is from supplemental light. DLICALC is designed to answer these questions in two ways. First, it can estimate a supplemental DLI from your supplemental light source. Second, it can estimate hours of lamp operation to achieve a target supplemental DLI.

In order to determine how long to operate supplemental lights each day to achieve a target DLI, the target supplemental DLI, lamp type (i.e. HPS, metal halide, etc.), supplemental light intensity value and the corresponding unit of measurement (i.e. f.c., µmol·m^{-2}·s^{-1}) must be entered into the program. Note that converting f.c. to µmol·m^{-2}·s^{-1} and vice versa requires a specific conversion factor that DLICALC integrates into its calculations for different light sources. From this information, the number of hours needed to operate supplemental lights is calculated. For our young plant grower in the example earlier, the HPS lamps would need to operate for approximately 16 hours to provide 4 supplemental mol·m^{-2}·d^{-1}. Alternatively, to determine the amount of supplemental light provided by an existing supplemental lighting program, the lamp type, hours of operation, supplemental light intensity and the corresponding unit of measurement must be entered. This information is used to calculate the supplemental DLI. For the bedding plant grower in the second example, the MH lamps operating provide 1.8 mol·m^{-2}·d^{-1} for the bedding plants.



The central feature of the DLICALC is to calculate either the amount of supplemental photosynthetic light provided by an existing program or the amount of time required to operate an existing supplemental light source to achieve a target supplemental daily light integral.

Additional Information Helps With Light Measurement

While the main function of DLICALC is to help manage supplemental lighting, there are several other factors that contribute to the greenhouse light environment. In addition to calculating supplemental DLI and hours of lamp operation, DLICALC contains information on measuring light in the greenhouse and estimating the natural DLI, as well as tips for using shade in the greenhouse.

One of the most important aspects of photosynthetic light management is successfully measuring the light in your greenhouse. However, there are several things to remember in order to record accurate light measurements. For instance, the type of measurement (instantaneous versus cumulative), sensor type and calibration, and sensor placement and clean-

Growers using DLICALC can more easily calculate how much supplemental lighting they are applying to their crops. High-pressure sodium lights are one of the most common ways to provide additional photosynthetic light.

liness all impact light measurements.

In DLICALC, we provide some basic guidelines, resources, and supplemental materials to assist growers in measuring photosynthetic light in the greenhouse. Measuring photosynthetic light is the only way to accurately measure the environment in your greenhouse. We provide a description of light units and terminology and provide several publications dedicated toward a better understanding of measuring and quantifying the light environment in greenhouses. However, we know not everybody will have access to some of the tools necessary to measure ambient light. Therefore, we discuss the nature of light transmission of outdoor light into a greenhouse and include monthly outdoor DLI maps developed at Clemson University.

Although many growers are concerned about increasing the DLI in greenhouses, it is also common to reduce the DLI when ambient light is high or when low-light crops, such as phalaenopsis orchids, are being produced. One of the features of DLICALC is a page dedicated to best management practices and shading.

The ultimate goal of DLICALC is to enable growers to better manage supplemental lighting and greenhouse light in general. We hope that DLICALC will be a useful tool for growers to help manage the photosynthetic light in the greenhouse, as well as other aspects of managing the light environment. While DLICALC will not have the ability to tell a grower exactly what the total DLI (ambient solar + supplemental) is, we hope that it will be a step in the right direction of having greenhouse growers make informed decisions when managing photosynthetic light. **GG**

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