LIGHTSCOUT™

DLI 100 LIGHT METER

Catalog # 3405

User manual

Spectrum

Technologies, Inc.

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Thank you for purchasing a LightScout DLI 100 Light Meter. Please read this manual thoroughly before using your instrument.

The DLI 100 accurately measures the PAR light that falls on it over a 24 hour period (the Daily Light Integral, or DLI), giving you the ability to match a plant's light requirements with the actual light conditions at that location.

- Simple, one button operation
- An affordable, first step in measuring light
- Measure PAR light (Photosynthetically Active Radiation - the range between 400 and 700 nm)
- With the push of a button, the meter runs for 24 hours and calculates your Daily Light Integral (DLI)
- Real-time intensity levels are shown every 4 seconds in $\mu mol \cdot m^{-2} \cdot s^{-1}$ (or footcandles)
- Packaged in sets of 3 light meters
- 3V CR2032 Battery included - approximate battery life: 60 DLI calculations

For support, or to place an order, call:
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Quick Start

1. **Decide where you want to measure** Page 4
   The DLI 100 comes as a set of three units so you can compare the amount of light received in multiple places on the same day.

2. **Start measuring** Pages 5-7
   Press the button on the shoulder of each DLI 100. The LEDs will light upward, and will blink every 4 seconds to show the current light intensity. Read the value from the right side of the LEDs.

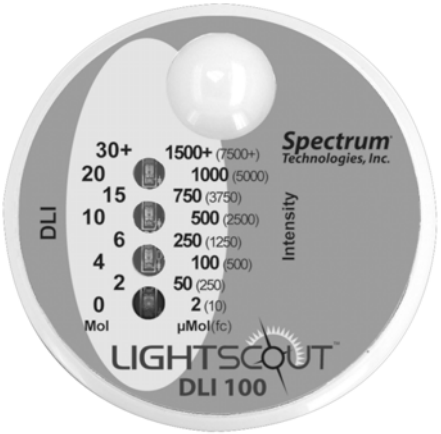
3. **Wait 24 hours**
   The DLI 100 will sum the light measurements for 24 hours to compute the Daily Light Integral (DLI).

4. **Read the Daily Light Integral (DLI)** Pages 5-7
   After 24 hours the DLI 100 will blink every second for the next hour to show the DLI value. Use the numbers to the left of the LEDs. If the display is dark, press the button to wake it and see the value for 10 seconds.

5. **Act on what you've learned** Pages 8-11
   If you've learned that your plants aren't getting enough light, what are you going to do to change that?

6. **Repeat**
   Choose another area and repeat the process for maximum benefit.

Important: Your mother was right. Don't run with scissors, and because of the spike on the DLI 100, be careful with it as well.



Where to Measure?

The DLI 100 comes as a set of three units so you can compare the amount of light received in multiple places, without the uncertainty caused by environmental differences across multiple days.

Use a "Control"
Use two of your DLI 100s to measure two locations of primary interest—on a greenhouse bench, or on a shaded green or tee box at a golf course. Use the third as a "control" - let it receive the maximum light, either outside your greenhouse, or in full sun, far from the trees.

In a Greenhouse
Place DLI 100s where you can compare light levels and DLI (Daily Light Integral) with and without hanging plants and shades. Use pots with soil or media to hold the DLI 100 upright. Place the third DLI 100 outside to measure transmission loss through the structure.

Shaded Tees and Greens
Use the DLI 100 to compare the light received by healthy and stressed areas of tees and greens. By placing one unit in the stressed area, one in a healthy area, and the third nearby with full sun, areas of destructive shade can be documented, and the minimum light level necessary can be determined.

In the Crop Canopy
To measure the incident light and/or DLI at, in, or below the crop canopy, secure the DLI 100 at the proper location and height. For low plants, this can be as simple as inserting the spike into the ground or into a container filled with soil or media. For taller crops, set a plastic or metal pipe into the ground, and slip the DLI 100 spike into the top to hold it at the desired height.

Please consult with your Spectrum representative to discuss expected results as well as additional ways to use your DLI 100 Light Meter.

Using the DLI 100

Place the DLI 100 in the ground at the desired location for evaluating the amount of available sunlight. In a greenhouse insert the meter into a container of similar size (containing substrate only) to that of the crop being grown. By so doing, the meter is receiving the same amount of light at the same height as the growing crop. Ensure that the face of the unit is generally parallel to the ground.

Light Gathering Mode

To turn the DLI 100 press the power button located on the shoulder of the device. When the power is applied, the four LEDs will illuminate sequentially from bottom to top. Thereafter, one or more LEDs will flash every 4 seconds, indicating the amount of light currently being received.

The DLI 100 measures the actual light intensity every 20 seconds, then displays that value every 4 seconds until the next measurement is made.

Note: While the DLI 100 is gathering data, pressing the power button will turn off the unit (the four LEDs will illuminate sequentially from top to bottom), and the measurement process will be cancelled. Pressing the button again will start a new 24 hour measurement period.

DLI Display Mode

After 24 hours of continuous operation, the device will stop accumulating light measurements. One or more LEDs will flash every second to indicate the Daily Light Integral (DLI) for that location.

The device will shut itself off after displaying the DLI value, but the DLI measurement will be retained in memory. The last DLI value computed can be retrieved from memory by pressing the power button to turn on the unit. The DLI value will flash every second for 10 seconds.

Important: After 10 seconds the DLI value will be erased, and a new 24 hour measurement period will begin. Pressing the button again before 10 seconds has elapsed will turn the unit off and save the DLI value.

Reading the Display

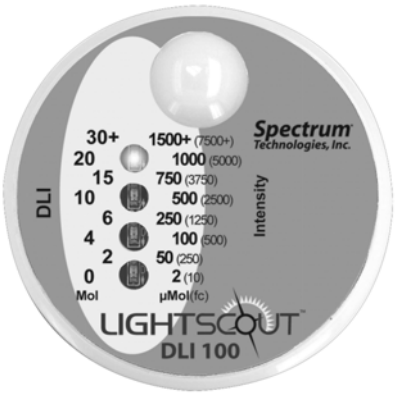
The DLI 100 Light Meter has 4 LEDs that are used to indicate different levels of light - both intensity and Daily Light Integral (DLI).

Numbers to the **right** of the LEDs are used during the Light Gathering Period to indicate current light levels in $\mu mol \cdot m^{-2} \cdot s^{-1}$ (micromoles) or fc (foot candles - using the sunlight approximation of 1 $\mu mol \cdot m^{-2} \cdot s^{-1}$ = 5 fc). The LEDs flash once every four seconds.

Numbers to the **left** of the LEDs are used to display the DLI value in $mol \cdot m^{-2} \cdot d^{-1}$. The LEDs flash once per second.

For all numbers, the important phrase to remember is "*at least*". The light level is *at least* the number indicated (and below the next number up).

One LED
When one LED is flashing, read the number next to it. The light level will be *at least* that number. In the image below:



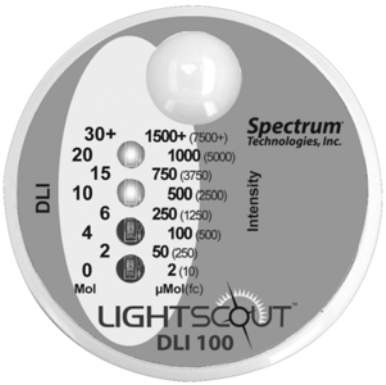
During the Light Gathering period, by reading the right numbers, the light intensity would be in the range 1000-1499 $\mu mol \cdot m^{-2} \cdot s^{-1}$ ("1000" is lit, and the top of the range is less than 1500, the next number up). The footcandle range would be 5000-7499.

In DLI Display mode, by reading to the left, the DLI value would be in the range 20-29 $mol \cdot m^{-2} \cdot d^{-1}$ ("20" is lit, and the top of the range is less than 30, the next number up).

Two LEDs
If the light level is between two LEDs, then both flash. In this case, use the number between them. For the image at the top of the facing page:

During the Light Gathering period, by reading the right numbers, the light intensity would be in the range 750-999 $\mu mol \cdot m^{-2} \cdot s^{-1}$ ("750" is between the two lit LEDs, and the top of the range is less than

1000, the next number up). The footcandle range would be 3750-4999.

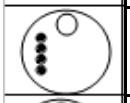
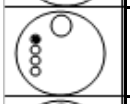
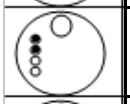
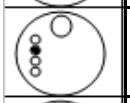
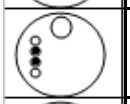
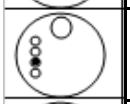
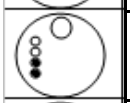
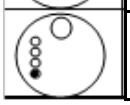


In DLI Display mode, by reading to the left, the DLI value would be in the range 15-19 mol·m^{-2}·d^{-1} ("15" is between the two lit LEDs, and the top of the range is less than 20, the next number up).

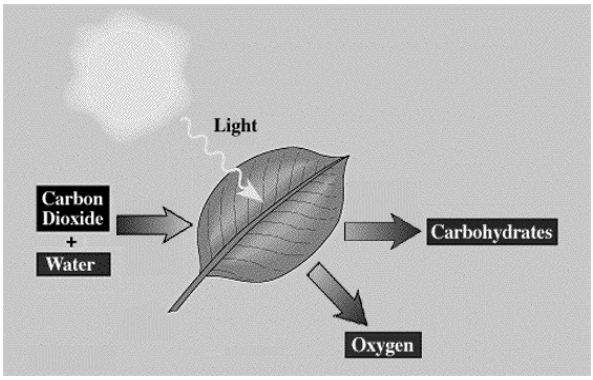
Four LEDs

Under the highest light levels, all four LEDs flash. The numbers at the top of the display (30+, 1500+, 7500+) provide the "at least" values for these light levels.

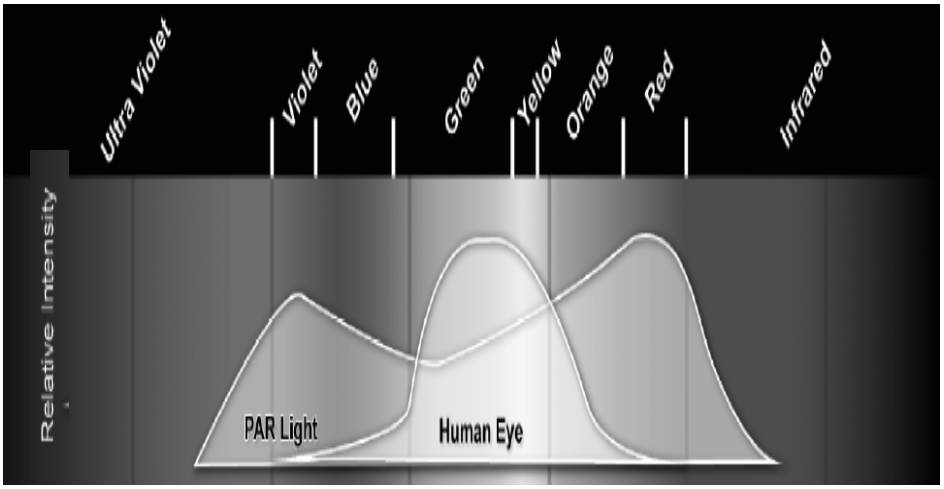
Please see the chart below for the explicit ranges used on the DLI 100 Light Meter.

	DLI	Light Gathering	
	mol·m^{-2}·d^{-1}	µmol·m^{-2}·s^{-1}	(fc)
	(30+)	(1500+)	(7500+)
	(20)-29	(1000)-1499	(5000)-7499
	(15)-19	(750)-999	(3750)-4999
	(10)-14	(500)-749	(2500)-3749
	(6)-9	(250)-499	(1250)-2499
	(4)-5	(100)-249	(500)-1249
	(2)-3	(50)-99	(250)-499
	(0)-1	(2)-49	(10)-249

Light Intensity



The light that drives photosynthesis in plants is Photosynthetically Active Radiation, or PAR light. This is also referred to as Quantum light, because it is measured in units of moles striking an area over time. Though PAR light ranges from 400 to 700nm, the region brightest to human eyes is the area of least effect on plants.



Light meters measure light intensity – the instantaneous amount of light delivered to an area. During the 24-hour light gathering period, the DLI 100 functions as a light meter.

Top image: http://snhs-plin.barry.edu/cell-biology/photo1.gif

Effect of light intensity on whole-plant photosynthesis

Generally, the net photosynthetic rate of a growing plant increases as light intensity increases (Figure 1). The light intensity that corresponds to a net photosynthetic rate of zero is known as the light compensation point. As light intensity increases so does the net photosynthetic rate of the plant until the light saturation point is reached. The light saturation point is the light intensity that, above which, net photosynthetic rate ceases to increase with a subsequent increase in light intensity. Plants adapted for low light conditions will reach maximum net photosynthesis at lower light intensity levels. Plants adapted for high light conditions require higher light intensity levels in order to achieve maximum photosynthesis.

The light measurement ranges displayed by the DLI 100 are specifically designed to correspond to the light compensation and light saturation points for the majority of plants.

Please consult your Spectrum representative for more information regarding optimal light intensity and your crop.

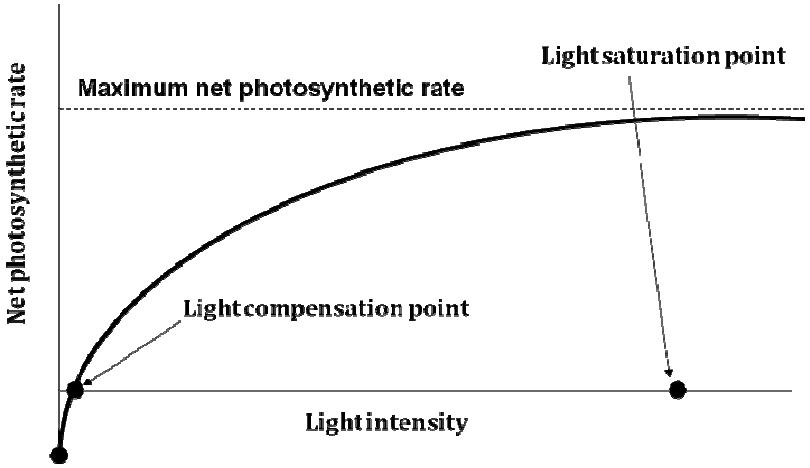


Figure 1. General response curve of net photosynthetic rate of plant leaves to increasing light intensity.

Cumulative Light (DLI)

If photons were raindrops, light meters would show the intensity of a rainstorm. A five-minute rainstorm may look impressive, but often provides less water than an all-day drizzle. As cumulative rainfall is measured with a rain gauge, the cumulative quantity of light is measured using the DLI 100, or a light sensor with a data logger. The daily total of quantum light is called the Daily Light Integral, or DLI, and is measured in units of $mol \cdot m^{-2} \cdot d^{-1}$ (moles per meter-squared day - the area, meters-squared, is often assumed, and therefore omitted in common use, leaving moles/day). DLI quantifies the light available to plants to perform photosynthesis.

On a sunny winter day in the middle latitudes, a plant receives about 9 moles/day. If it is cloudy, the DLI drops to 3 moles/day. In the summer, the DLI for a sunny day is about 26 moles/day and 12 moles/day for a cloudy day.

Each type of plant has a different DLI range for optimal growth. DLI is directly correlated with plant quality, and a minimum amount of light is required for marketable plants. Measuring DLI over a growing season and comparing it to results can help a grower decide which varieties work for his or her location.

Effect of light intensity on plant growth and quality

Relative Light Level	**Daily Light Integral (DLI)** $mol \cdot m^{-2} \cdot d^{-1}$	**Light intensity at Noon** $\mu mol \cdot m^{-2} \cdot s^{-1}$	**Generalized Plant Growth Response**
Very Low	2 to 5	100 to 200	Poor quality
Low	5 to 10	200 to 400	Minimum acceptable quality
Medium	10 to 20	400 to 800	Good quality
High	20 to 30	800 to 1,200	Excellent quality
Very high	30 to 60	1,200 to 2000	Excellent quality

Table 1. Generalized plant responses to different light levels.
Please note that it is not possible to convert a single light intensity reading to DLI. Additionally, temperature is an important factor of plant growth and quality (table adapted from Hamrick, Debbie ed. Ball Red Book. Batavia, IL: Ball Publishing. 2003).

Table 1 provides a generalization of plant responses to increasing light intensity. Researchers have shown that light intensity and temperature are critical factors that affect plant growth and quality (Faust, 2003).

Growing plants under very low light conditions (2-5 mol·m^{-2}·d^{-1}) typically results in poor plant growth.

Under low light conditions (5-10 mol·m^{-2}·d^{-1}) plant growth quality is temperature dependent. With cool growing temperatures (below 65°F/18°C) plant quality can be good as the leaves and flowers develop slowly, providing the plants time to accumulate energy from sunlight. Under warmer temperatures (above 75°F/24°C) plant development is much faster, but the plants have insufficient energy from sunlight to develop.

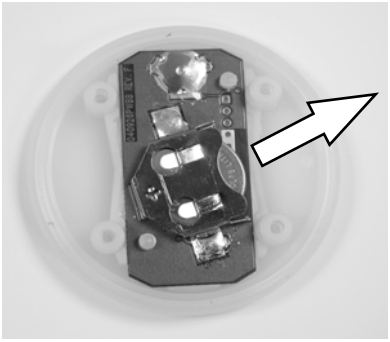
Commercially acceptable plant growth generally occurs under medium light conditions (10-20 mol·m^{-2}·d^{-1}), with production of normal flowers and branching.

The highest quality plants are generally grown under high light conditions (20-30 mol·m^{-2}·d^{-1}) which generally result in higher branching, higher number of flowers, and better root growth. With very high light conditions (over 30 mol·m^{-2}·d^{-1}) and cooler temperatures superior plant quality can be achieved (Lopez and Runkle, 2008).

Faust, J.E. 2003. Light, p. 71-75. D. Hamrick, (ed.) Ball Redbook: Crop Production vol. 2, Ball Publishing, Batavia, IL.
Lopez, R.G. and E.S. Runkle. 2008. Photosynthetic daily light integral during propagation influences rooting and growth of cuttings and subsequent development of New Guinea impatiens and petunia. HortScience 43:2052-2059

Replacing the Battery

The LightScout DLI 100 Light Meter uses a standard 3V Lithium CR2032 battery. A battery is projected to record 60 days, depending on the measured light intensity. To change the battery:



1. Remove the four screws from the back, and lift the top off the meter. Do not lose the clear gasket (O-ring).
2. Turn the top over, and use screwdriver to gently push the old battery out.
3. Slide the new battery in, with the "+" side toward you.
4. Replace the top and the gasket on the case. It will fit securely only one way—the sensor dome is on the side opposite the power button. Tighten the four screws.

Warranty

The LightScout DLI 100 Light Meter is warranted to be free from defects in materials and workmanship for a period of 1 year from the date of original purchase. During the warranty period, Spectrum will, at its option, either repair or replace products that prove to be defective. This warranty is void if the product has been damaged by customer error or negligence, or if there has been an unauthorized modification.

Returning Products to Spectrum
Before returning a failed unit, you must obtain a Returns Material Authorization (RMA) number from Spectrum. You must ship the product(s), properly packaged against further damage, back to Spectrum (at your expense) with the RMA number marked clearly on the outside of the package. Spectrum is not responsible for any package that is returned without a valid RMA number or for the loss of the package by any shipping company.

DECLARATION OF CONFORMITY

Spectrum Technologies, Inc.
12360 S. Industrial Dr. East
Plainfield, IL 60585 USA

Item Number:	3405
Description:	LightScout DLI 100 Light Meter
Type:	Electrical equipment for measurement, control, and laboratory use
Directive:	2004/108/EC
Standards:	EN 61326-1:2006
	EN 61000-4-2:1995, including A1:1998 and A2:2001
	EN 61000-4-3:2002
	EN 55011:2007

Michael J. Dunning, Weather Products Manager January 4, 2010

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