# Daily Dose of Sun

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Four essential requirements for plant growth are nutrients, water, air, and light. As turfgrass managers we spend time and energy focusing on obtaining the right balance of nutrient and water inputs. We have very little, if any control over air, so that is often overlooked. A lack of light causes plant elongation, decreased root growth, thinner cuticles, fewer chloroplasts, decreased photosynthetic rates, and greater succulence (Fry and Huang, 2004). On a golf course, shade is most often caused by trees, which also alter microclimates, use water and nutrients intended for the turfgrass, and cause maintenance headaches with mowing and trimming. Trees can even affect the playability of a golf course. When was the last time you did something to manage your light inputs?

Greenhouse managers manage light inputs by using supplemental lights and shade cloths. Turning on and off supplemental light sources is done to extend natural day length or to increase Daily Light Integral (more on this to come). Opening and closing retractable shade curtains reduces excessive light during the summer months which can lead to heat stress and inhibit photosynthesis (Buck, 2010).

Managing turfgrass does not afford the opportunity to use artificial lighting or shade cloths to manage light levels. This leaves superintendents implementing a traditional practice for maintaining turfgrass in shade, such as reducing nitrogen, applying plant growth regulators, raising the mowing height, or planting shade tolerant cultivars. The alternative to management is tree removal and trimming. Although it is easy for a superintendent to understand tree removal and trimming with respect to turf health, when a tree is not a problem for golfers it can be difficult to communicate the need for removal or trimming.

**Figure 1:** Turfgrass under shade. (Andrew Hollman, U of M)

The last time you removed or trimmed a tree: How did stakeholders, such as golfers, the greens chairman, the club manager, or the head golf professional, respond? Were stakeholders involved in the decision? You may be familiar with ArborCom and other companies who use computer software to generate light analysis. This information can be very useful for validating tree management decisions, especially to those who do not manage turfgrass on a daily basis. Unfortunately these services cost thousands of dollars. Light sensors, which have been used by greenhouse managers for years, can also assist tree management decisions and cost as little as $200.

### *Light 101*

The human eye perceives light in the visible (400 nm to ~700 nm) wavelengths, but has the most sensitivity to green (500-600 nm) wavelengths. Foot candles or lux is the measurement of light as the human eye sees it (see Figure 2). Although foot candles and lux have been measured historically, they should not be measured. Instead Photosynthetically Active Radiation (PAR) or quantum light should be measured. PAR light ranges from 400-700 nm, but it is more affected by blue (400-520 nm) and red (610-750 nm) wavelengths. Blue and red wavelengths are the drivers of photosynthesis.

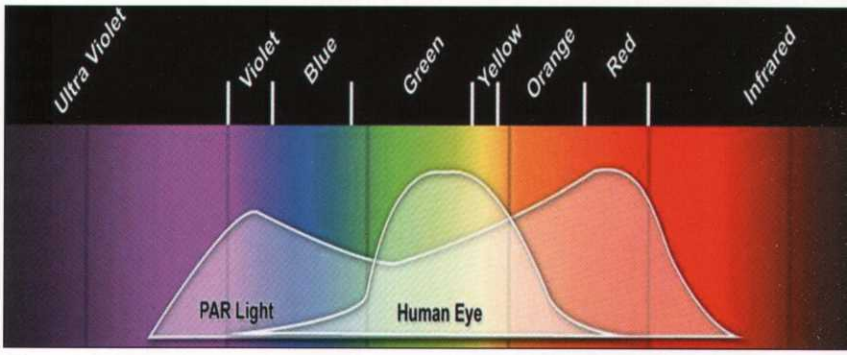


**Figure 2:** Wavelength spectrum covered by Photosynthetically Active Radiation (PAR) and lux (Human Eye) measurements. Notice the greater intensity of measurement at blue and red wavelengths for PAR and at green wavelengths for lux. (Spectrum Technologies)

In shade, the light type and quantity is altered. Plant material, such as trees, reflect light back to the atmosphere, absorb light for photosynthesis, and transmit light through the leaves. Plants below only receive transmitted light which has a low number of blue and red wavelengths. Building shade has various effects depending on the material, color, and many other factors. The effects can range from a total absorption of certain wavelengths to the complete reflection of wavelengths.

### *How is light measured?*

PAR light is measured as the total number of photons striking a square meter in a second (µmol/m2s). This is comparable to the rate rain is falling in a given location. Both PAR and foot candle measurements are point in time measurements. We all know light outdoors changes throughout a day and from day to day. Researchers use another measurement to provide a more complete story, Daily Light Integral (DLI). DLI is the summation of the total number of photons striking a square meter in a day (moles/day). Basically, DLI is the addition of PAR measurements taken throughout a day or the total rainfall in a given location over a day.

### *How much light does turfgrass require?*

Lots of research has been conducted on the effects of shade on turfgrass, however, research on light requirements is lacking. It is known that photosynthesis in cool-season turfgrass is maxed out somewhere between 534 and 1072 µmol/m2s. A range exists,

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because between and within species there are differences in photosynthetic saturation points. Research tells us that most turfgrass requires 4 to 5 hours in photosynthetic saturation each day to be healthy. Roughly speaking, cool-season turfgrass requires a DLI between 21 and 41 moles/day (Fry and Huang, 2004). There is very little published research on the DLI needed for individual cool-season turfgrass cultivars. We can expect traditionally shade tolerant turfgrass, such as fine fescue, to perform well on the low end (21 moles/day) and traditionally sun loving turfgrass, such as Kentucky bluegrass, to perform best near the higher end (41 moles/day). I recommend that you correlate various DLI measurements to turfgrass quality on your site to determine the optimal DLI for your site.


**Figure 3:** Instant (Hand-held) light meter. Great for collecting point in time measurements. (Spectrum Technologies)

### *What tools are available to measure light?*

There are several manufacturers but really only two types of light sensors, those that measure instant levels and those that calculate DLI. Models that measure instant levels start around $200 *(See Figure 3).*

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**Figure 4:** Mini weather station positioned on the side of a golf green for collecting daily light levels. (Derek Settle, CDGA)

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These sensors are hand-held and operate with a simple on/off switch. It is important to orient hand-held sensors vertically to get accurate measurements. Check out Spectrum Technologies FieldScout Quantum Light Meter for $199.

Sensors that calculate DLI are preferred, because these sensors report how much light is received over time. Most often these models measure additional environmental parameters, such as temperature, and cost $500 and up (see Figure 4). Check out Spectrum Technologies Greenhouse Tracker for $545. For a sensor that only measures DLI look at Spectrum Technologies LightScout DLI 100. This sensor collects light data, calculates DLI after 24 hours, and reports the DLI with a simple LED system (see Figure 5). This sensor is sold in a pack of three for $190. All sensors that measure DLI must remain in the same location for at least 24 hours and should be oriented vertically to obtain accurate measurements.

*I mention Spectrum Technology products, because I am very familiar with their products. Onset, Campbell Scientific, and Apogee make comparable products.

### *Using light measurements?*

Choose a sensor that fits how you plan to use the sensor. Instant sensors are best used for mapping light and demonstration. Using a coordinate system, measurements can be collected across a site to obtain light maps. I have also seen superintendents use instant sensors to point out light levels and the associated turf health during green committee meetings. DLI sensors are most useful for validating how much actual light an area receives over individual and multiple days.

Light sensors are an economical tool to test whether turfgrass is receiving enough light. Often the story light sensors tell is well known by the superintendent. The real value of a light sensor is putting science and data behind what is known by the superintendent. Light data can validate removing or trimming a tree to stakeholders. Ultimately, better qualified and unified decisions about tree management are best for all parties. Now where is the chainsaw!

Figure 5: LightScout sensors placed on and around a golf green to collect daily light levels. (Scott Lemke)

*(Editor's Note: Aaron Johnsen is a Professional Product Advisor with WinField Solutions and an adjunct lecturer at the University of Wisconsin - River Falls. He can be reached at arjohnsen@landolakes.com or 651.895.2601.*

*References: Buck, Johann. 2010. Personal Communication. Fry, J. and B. Huang. 2004. Applied Turfgrass Science and Physiology. John Wiley & Sons, Inc. Hoboken, NJ.)*