Plants, Light, and LEDs: Putting It All Together

Part 4 – Measuring Light
Is it better to use a cup or a spoon?

Topics

- When we measure light, what exactly are we measuring?
- What instruments are used to measure light?
- Why aren't all light measuring tools the same?
- Can we compare measurements of sunlight to those of lamp light?
- What you see may not be what you get.

When we measure light, what exactly are we measuring?

A photon is a single packet of electromagnetic energy that has characteristics of both waves (such as the bending of light as it passes through a prism) and particles. For many years there were powerful debates over whether photons were waves or particles. The final result of many experiments is that photons have properties common to both waves and particles.

While we commonly think of a photon as being a particle of light, all types of electromagnetic radiation, from low energy, long wavelength radio waves to high energy, short wavelength x-rays, are photons. That portion of the electromagnetic spectrum which we call "light" is only a very small part of the whole. But for our purposes we're only considering photons of light.

The instruments used to measure light take advantage of the interaction of photons with matter. The actual mechanics of measuring light, in which either individual photons are counted or the rate at which photons strike a surface is measured, are generally accomplished using electronic components called photodiodes or photoresistors. These have the ability to measure the amount of light hitting them as the light modifies the electric current flowing through them.

What instruments are used to measure light?

A photometer is any type of instrument used to measure light. There are many different kinds of photometers, some of which are common household instruments.

For example, modern cameras all have a built in photometer that helps the camera set exposure times and apertures. Professional photographers often use a separate, hand-held photometer to measure the light reflected from different objects in their setup, yet this type of photometer is very similar to those built directly into household cameras.

Other types of photometers are used for measuring levels of sunlight. Some are simple hand-held devices that look similar to the photometers used in photography. Others have remote sensors that send light measurements back to a computer.

A specialized group of photometers used for measuring sunlight are called PAR meters. PAR is an acronym for Photosynthetically Active Radiation, which refers to that portion of the spectrum of sunlight that scientists have determined contains the light colors plants use for photosynthesis. These types of meters excel at measuring differences in sunlight levels, and as an example, are commonly used in testing the light levels inside greenhouses.

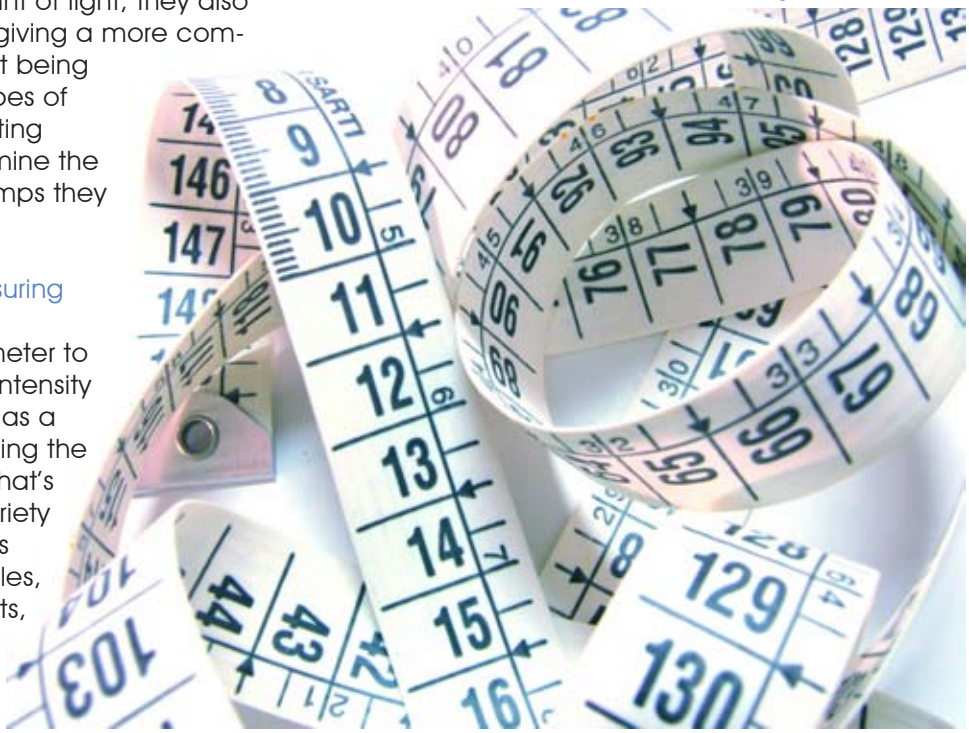
There are also highly specialized photometers called spectroradiometers which are used more in laboratories than in the field. Highly sensitive devices, spectroradiometers not only measure the total amount of light, they also break it down by color, giving a more complete analysis of the light being tested. These are the types of instruments used by lighting manufacturers to determine the characteristics of the lamps they produce.

Why aren't all light measuring tools the same?

When you use a photometer to measure light, the light intensity information is displayed as a single number representing the light level. The number that's reported can be in a variety of different units, such as Lumens, Lux, Foot-Candles, micro-Einsteins, PAR Watts, etc. Why are there so many different types of numbers, and are they the same thing with different names?

No, all of these types of units are very different, and have different meanings. Even though all photometers are, typically, making the same kind of measurement, the photometer is interpreting the information it collects to tell you something very specific. For example, a light meter used for photography adjusts the information by making colors that are more visible to the human eye, such as yellow and green, count more than colors that we don't see as well. Obviously a photometer such as this will not give a very useful indication of how good the light is for growing plants.

Photometers are made for very specific purposes, for which they are very well suited. Photometers used by photographers provide excellent information about how well the available light is for taking photographs. PAR photometers are extremely useful for determining if the sunlight in a greenhouse is adequate for growing plants. If you use a photometer intended for photography to measure the quality of light in your greenhouse, it will tell you how well your pictures are likely to turn out, but doesn't really say much about whether your plants will grow well. Similarly, your PAR meter will tell you how well your tomatoes will grow, but not how well they'll photograph. Always make sure the tool you select is appropriate for the measurements you are taking.



Can we compare measurements of sunlight to those of lamp light?

No, we can't compare measurements of sunlight to those of lamp light, for two reasons.

The first problem is that all of the published standards for the amount of light needed to grow plants are based on sunlight. But since we know sunlight and lamp light are not the same, and that sunlight contains many colors of light that are not used efficiently by plants, and that no two types of lamp light are the same, it's obvious that measurements of sunlight are not comparable to those of lamp light.

Suppose a researcher publishes a paper that says you need "X" amount of sunlight to grow plants, and you use the exact same photometer to measure the light level generated by a metal halide lamp designed for growing plants, and the amount of light measured is much less than "X". Does this mean the metal halide lamp is not capable of growing plants? No, because part of the reason the reading from the metal halide lamp is lower is that it doesn't produce as many colors of light as sunlight. But if it produces enough light of the colors plants need, it can grow plants very well even if the photometer (designed for measuring sunlight) says it won't.

The second problem is that, except for spectroradiometers, which are more common in laboratories than in the field, photometers do not give accurate readings of the light generated by man-made lamps. Research has shown that photometers underreport the amount of light when used to measure light from man-made light generators. And when you measure light from the LED grow lamps, which are by far the most efficient type of grow lamp, the measurements made by photometers are even more unreliable. In fact, the user manuals provided by photometer manufacturers clearly state that these instruments should only be used for measuring sunlight, not lamp light.

At this time, the fact is that all standards for the amount of light needed for growing plants are based on sunlight, which can't be compared directly to lamp light. At the same time the photometers people are generally using to measure the amount of light they are getting from man-made light generators are not suitable for that task.

What you see may not be what you get.

If we can't trust our photometers to measure lamp light, why not just go by how bright the lamp looks? After all, sunlight is really bright and it grows plants very well indeed. Shouldn't a lamp that looks really bright work better for growing plants than one that doesn't looks so bright?

Now that we know that sunlight and many types of lamp light contain a lot of colors of light that appear very bright to the human eye but are not used efficiently by plants, we can understand that light which "looks bright" to human eyes may not "look bright" to a plant. The truth is that the more plant-efficient light a grow lamp generates, the less bright it will look compared to a grow lamp that is less plant-efficient but that produces a lot of light that looks bright to the human eye. LED grow lamps, which are currently the most plant-efficient lamps available, look considerably less bright than most other types of grow lamps.

There still aren't any perfect answers when it comes to measuring light from man-made light generators in order to compare their ability to grow plants. Most answers come over time, from the field, as growers learn the new tricks required to use the new technology.

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