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## (turfgrass talk)

# An easy PAR

Unlike other factors that have a big influence on turf growth — such as temperature, water or fertilizer — light can seem more complicated, and it's rarely discussed in specific quantities. But it isn't that difficult once one understands the terminology and the units of measurement. There are just three technical terms to learn, and after that, it is all quite clear.

The first term is “photosynthetically active radiation” (PAR). This light, which has wavelengths from 400 to 700 nanometers, is the one grasses use for photosynthesis. When we talk about light and shade for grass, what we are really talking about is PAR.

The second term is “photosynthetic photon flux density” (PPFD). This is the measurement for PAR. Just as irrigation may be measured in liters or millimeters, fertilizer may be measured in kilograms, and temperature may be measured in degrees, PAR is measured as PPFD. Light is made up of photons, and PPFD is the measurement of the quantity of photons incident on a 1-square-meter surface in 1 second. The specific unit for PPFD is micromoles of photons per square meter per second.

That sounds complicated, but in terms of what it means for golf course superintendents, PPFD is on a scale that goes from zero at night up to a maximum of about 2,000 on a sunny summer day. Typically, PPFD

will be somewhere in between those values when there is shade or clouds, or when the sun is low in the sky. In your office, with normal lighting, PPFD will probably be less than 10. When there are low clouds, PPFD may be less than 500. In winter, even if it is sunny, PPFD may have a maximum at mid-day of about 1,400, because the sun remains low in the sky.

Every day, PPFD is zero until sunrise, after which it increases as the sun gets higher and higher in the sky. PPFD decreases late in the day until it falls to zero again when the sun sets. PPFD is a number between zero and 2,000, representing the quantity of PAR for a single second.

The third term is the sum of PPFD from every second during the day, and it's called “daily light integral” (DLI). PPFD is an instantaneous measurement of PAR, and DLI is a daily total of PAR. The units for DLI are moles of photons per square meter per day. This is for convenience, because taking the PPFD measurement for the 60 seconds in a minute isn't so bad, but try measuring the PPFD for the 3,600 seconds in an hour or the 43,200 seconds in 12 hours, and those PPFD units of micromoles get to be a really long number. By expressing DLI as moles rather than micromoles, the numbers are manageable.

The DLI will be about 60 on a cloudless summer day, and it may be less than 10 on a day with low clouds and rain from sunrise to sunset. It is more common to have DLI of 30 to 50 during summer, unless there are a lot of clouds.

This is where it gets interesting, and where these specific measurements of the quantity of PAR can be useful. Sometimes the grass can't grow well because of shade from trees or buildings. Sometimes one isn't sure whether the problem is due to soil issues, shade or lack of air movement. It is standard practice to look at shadows on the ground and count the hours of light that reach the turf, but this doesn't give a number for the PAR reaching the turf.

By measuring PPFD and/or DLI in shaded areas and then in unshaded areas, one can find the difference in PAR, which will inform any decisions about management changes. Knowing the exact values for PPFD and DLI also makes it a lot easier to communicate about shade problems by discussing the amount of PAR reaching the turf in certain areas and the exact reduction in PAR caused by trees, clouds or a building.

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