LIGHT FANTASTIC

Q&A for growing grass in the shade

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1. What is PAR?

PAR (= photosynthetically active radiation) it's that portion of sunlight (or even of artificial light) that has the correct wavelength to trigger and fuel photosynthesis in plants.

Light is made of photons, some have useful wavelengths for photosynthesis (400-700 nm), some don't (i.e. ultraviolet, infrared).

Chlorophylls ("A" and "B") absorb light (and therefore function) at two specific wavelength bands (400-500 nm and 640-700 nm), so even within PAR there are wavelengths that are more useful than others…

2. How do I measure PAR?

PAR is measured in mmol/m^2/s (that is, the number of useful photons hitting on a given area in one second), and indeed that is often one of the all-important parameters cited in the technical sheets of lighting rigs, or even of sodium-light or LED bulbs.

You can easily measure it with sensors called "Quantum PAR", some are available in portable stand-alone form (a sensor, a cable, a digital logger), some are embedded in the more advanced weather stations (Green-GO, www.greengosystem.com).

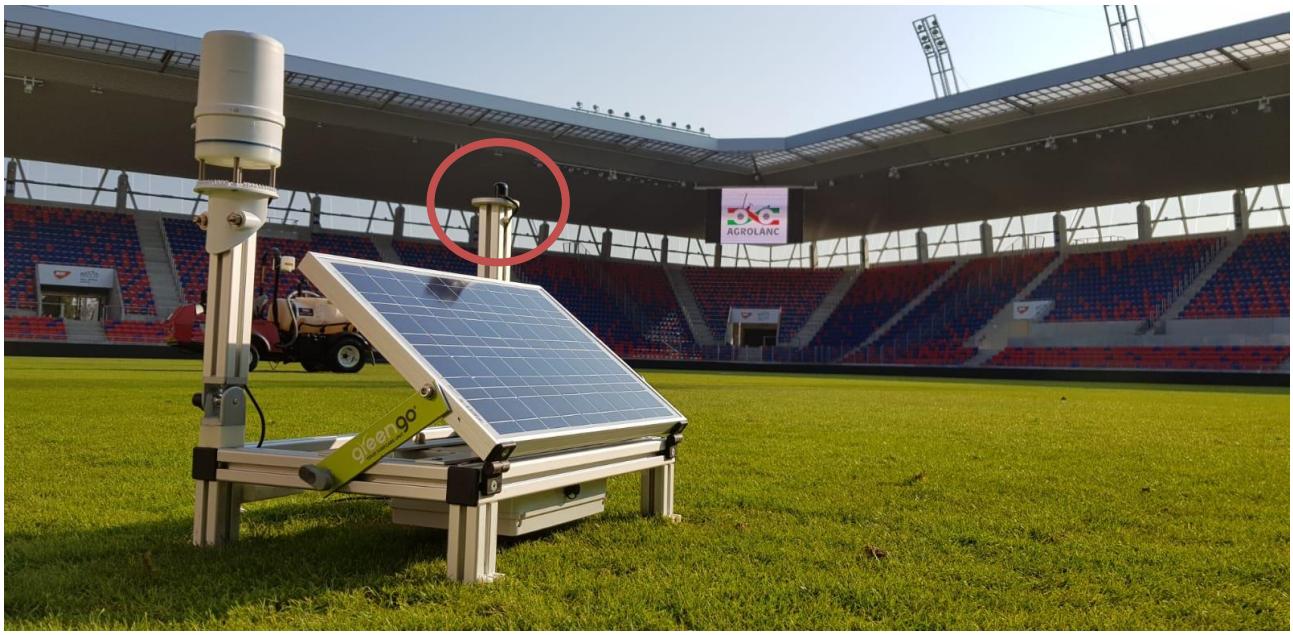

Fig. 1. Quantum PAR sensor on a Green-GO weather station.

3. OK but, how much PAR do I need?

Here opinions differ.

It is often reported that below **350 mmol/m^2/s PAR** intensity photosynthesis is severely hampered, however other scientists report photosynthesis as a reciprocal process and that **a lower PAR intensity can be offset by a longer exposure**.

Others report that cool-season (C3) turfgrasses max out their photosynthesis at a light intensity somewhere between **534-1072 mmol/m^2/s** AND that **4-5 hours at this saturating light intensity should be enough to see healthy turfgrass growth**.

However, you can't go far wrong if you assume that you need at least **400 mmol/m^2/sec** intensity for the plant to "work". This intensity can be the sum of sunlight and artificial PAR light, of course.

4. PAR varies much?

Look at this capture from a Green-GO dashboard (Fig. 2). Yellow line is from inside a stadium, azure line is from a training centre at a similar latitude at around Christmas 2019.

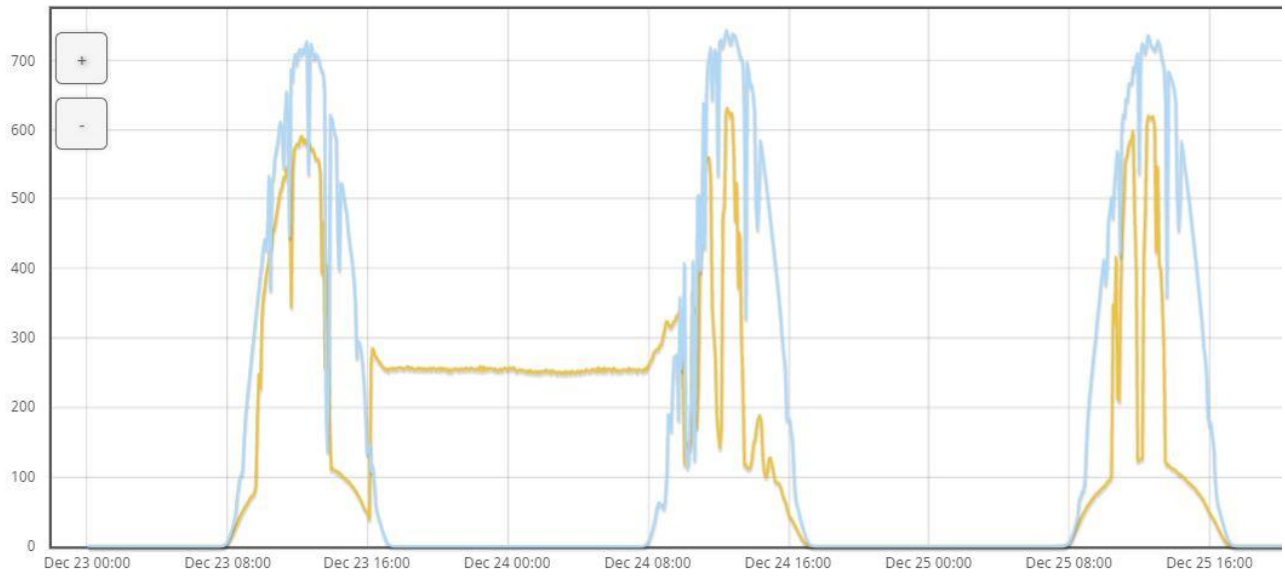

Fig. 2. PAR in stadium (yellow) and in training centre (azure) at Christmas 2019.

Notice the "fuller" and higher curve of light in the training centre. The slight dips in the azure curve are clouds, the much deeper dips in the yellow curve are architectural features in the stadium completely blocking the sun.

It is also easy to see the **PAR intensity provided by the artificial lighting rigs** in the stadium at night.

Of course, the **stadium PAR intensity will vary immensely according to where the measurement is take**n, much less for an open environment such as a training centre.

5. What is DLI?

Good question.

Remember when we said that photosynthesis is a reciprocal process, and that intensity and duration of light can sum up towards achieving plant photosynthesis?

Well DLI is the sum of all light that hits a given surface in one calendar day, regardless of intensity.

Think of it as measuring how much water is exiting a tap on any given day. Regardless of whether the tap is fully open for a few minutes or just dripping all day, or a combination of all the tap openings during that day. Just the total water pumped out in a day.

As such **DLI is a sum, expressed in mol/m^2/day** and it's measured with exactly the same devices as PAR, since it's just the sum of PAR in 24h.

6. Why is DLI important?

Some very patient and thorough plant scientists (and lighting companies) have worked out the minimum and optimum requirements for main turfgrass species. Here they are, as reported in some Author's work:

- Perennial ryegrass (50 mm mowing): 10 mol/m^2/d (Kruse et al.)
- **Perennial ryegrass** (25 mm mowing): **16 mol/m^2/d** (Richardson et al.)
- Perennial ryegrass (25 mm mowing and heavy traffic): 28 mol/m^2/d (Richardson et al.)
- Perennial ryegrass (25 mm mowing, overseeded in bermudagrass): 28 mol/m^2/d (Richardson et al.)
- **"Tifway" hybrid bermudagrass** (50 mm mowing)**: 23 mol/m^2/d** (Kruse et al.)
- **"Tifway" hybrid bermudagrass** (25 mm mowing)**: 28 mol/m^2/d** (Richardson et al.)
- "Celebration" bermudagrass: 19.5 mol/m^2/d (Kruse et al.)
- "Diamond" *Z. matrella*: 11.3 mol/m^2/d (Kruse et al.)
- **Bluegrass\meadowgrass (Poa pratensis)** (25 mm mowing): **11.1 mol/m^2/d** (Cockerham et al.)

In my opinion much more specific and in-depth research is needed before we can agree to some stringent DLI figures for each turfgrass species.

7. What does a DLI curve look like?

Remember those PAR curves for a stadium and a training centre? Here are the DLI curves for the same dates (Fig. 3)

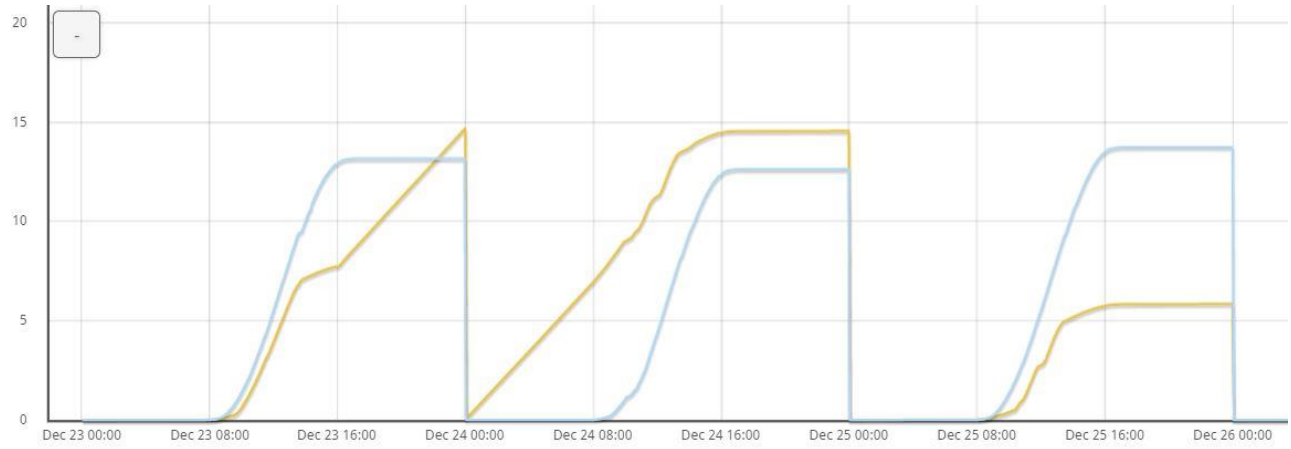

Fig. 3. DLI in stadium (yellow) and in training centre (azure) at Christmas 2019.

See how artificial light is capable, when turned on, to handily supplement sunlight and bring DLI in a stadium up to a degree comparable to an outdoor facility. On the contrary, see the difference in DLI when artificial lights are not in use (December 25th). See also how the curve changes when artificial lights are used.

7. OK, great. But what if I don't have all that DLI in my stadium? How many hours of artificial light do I need to apply?

Here Quantum PAR sensors (and DLI calculations) are a necessity.
In any given area of your pitch you must:

- Measure the DLI supplied by direct sunlight: do that by placing a Quantum PAR sensor or your Green-GO device in the area of the pitch you want to monitor. A couple of days readings should give you a good indication of the DLI.
- Measure the PAR intensity of your lighting rigs <u>in the dark</u> (10 minutes will do). Do so in the centre of the rig's layout, under a central bulb (this will give you the maximum intensity). And then apply the following empirical formulae:
    - PAR 100 mmol/m^2/s = 0,36 mol/m^2/h
    - PAR 150 mmol/m^2/s = 0,54 mol/m^2/h
    - PAR 200 mmol/m^2/s = 0,72 mol/m^2/h
    - PAR 250 mmol/m^2/s = 0,90 mol/m^2/h
    - PAR 300 mmol/m^2/s = 1,08 mol/m^2/h
    - PAR 350 mmol/m^2/s = 1,26 mol/m^2/h
    - PAR 400 mmol/m^2/s = 1,44 mol/m^2/h
    - PAR 450 mmol/m^2/s = 1,62 mol/m^2/h
- So, you have a DLI of 7 mol/m^2/d **(A)** in a certain given area of the pitch, you are growing perennial ryegrass mowed at 25 mm, which needs a minimum of 16 mol/m2/d **(B)** and your lighting rig's maximum intensity is 250 mmol/m^2/s, thus supplying 0,9 mol/m^2/h **(C)**. You will need to leave your lighting rigs on for a <u>minimum of</u> **(B - A) / (C) = 10 hours**