

## Frequently Asked Questions

# Photosynthetically Active Radiation (PAR) Units

### ***How can I evaluate the effect of different light sources on plant growth?***

The *Photosynthetically Active Radiation* (PAR) measure of radiant power is important in evaluating the effect of light on plant growth. In 1972 it was shown by K. McCree (*Agric. Meteorol.*, 10:443, 1972) that the photosynthetic response correlates better with the number of photons than with energy. This is expected because photosynthesis is a photochemical conversion where each molecule is activated by the absorption of one photon in the primary photochemical process.

PAR is defined in terms of photon (quantum) flux, specifically, the number of moles of photons in the radiant energy between 400 nm and 700 nm. One mole of photons is  $6.0222 \times 10^{23}$  photons ( $6.0222 \times 10^{23}$  is Avagadro's Number). The *Photosynthetic Photon Flux Density* (PPFD), i.e., the photon irradiance, is expressed in moles per square meter and per second (formerly, Einsteins per square meter and per second).

There is not a general conversion factor between photon measurements and energy or light measurements for broad band radiation. However, a specific conversion factor can be determined for a given spectral power distribution, e.g., a particular light source. This is of practical value because conventional lighting calculation techniques can be used for design of plant growth areas and because color corrected light or illuminance meters can be used to measure PAR values. Some plant scientists want a conversion for the photon flux in the 400 nm to 800 nm band although it is not the standard PAR metric (see CIE Publication 106, Section 8, 1993); this conversion also has been included.

#### **Multiply $\text{lm/m}^2$ (lux) by the given constant to obtain micromoles per second and per square meter ( $\mu\text{mol}\cdot\text{s}^{-1}\cdot\text{m}^{-2}$ )**

| <b><u>LIGHT SOURCE</u></b>      | <b><u>400-700 NM</u></b> | <b><u>400-800 NM</u></b> |
|---------------------------------|--------------------------|--------------------------|
| Incandescent (3000 K)           | 0.019                    | 0.036                    |
| High Pressure Sodium            | 0.012                    | 0.013                    |
| Mercury:                        |                          |                          |
| Clear                           | 0.011                    | 0.012                    |
| Phosphor Coated                 | 0.013                    | 0.014                    |
| Metal Halide                    | 0.014                    | 0.015                    |
| Fluorescent:                    |                          |                          |
| Cool White                      | 0.013                    | 0.013                    |
| Daylight                        | 0.014                    | 0.015                    |
| Design 50                       | 0.016                    | 0.017                    |
| 730, 735, 741, 830, 835         | 0.013                    | 0.013                    |
| 841, 850                        | 0.013                    | 0.014                    |
| GRO                             | 0.029                    | 0.030                    |
| GRO/WS                          | 0.019                    | 0.022                    |
| CWX, DX                         | 0.016                    | 0.018                    |
| Clear Day (sun and sky, 6000 K) | 0.018                    | 0.024                    |
| North Skylight (12,000 K)       | 0.020                    | 0.024                    |

**To obtain conversion factors from  $\text{lm/ft}^2$  (footcandles) to  $\mu\text{mol}\cdot\text{s}^{-1}\cdot\text{m}^{-2}$ , multiply the above factors by 10.8**