DLC Horticultural Lighting Resources:

Terms and Definitions

Definitions

Unless otherwise noted, this memo directly references the definitions from the American Society of Agricultural and Biological Engineers (ASABE) *ANSI/ASABE S640: Quantities and Units of Electromagnetic Radiation for Plants (Photosynthetic Organisms)*, and, where applicable, the Illuminating Engineering Society (IES) *ANSI/IES RP-16: Nomenclature and Definitions for Illuminating Engineering*.

Shedding some light on the nomenclature

Both plants and humans have developed photoreceptors for specific spectral ranges in the sun's electromagnetic output. Humans use specific photoreceptors in the eye to see the visible region of the electromagnetic spectrum, approximately from 380 to 770 nanometers (nm), as defined by IES. The human eye is not equally sensitive to each wavelength within that range, and measurements relating to human vision use a special weighting function called "V-lambda", or V_λ, that is most sensitive to green wavelengths.

Plants do not use human eyes as receptors for light, though. They use a unique set of photoreceptor pigments that enable photosynthesis and use other photoreceptors to absorb information about their surroundings. For photosynthesis, which represents the bulk of energy consumption for the plant, photosynthetically active radiation (PAR) ranges from 400 to 700 nm (as defined by ANSI/ASABE S640). The measured result of PAR can be reported in units of Photosynthetic Photon Flux (PPF), Photosynthetic Photon Flux Density (PPFD), or Photosynthetic Photon Intensity Distribution (PPID). To help users compare and understand horticultural terms and units of measure, we show their equivalents in human-based terms in the table below.

Table 1: Comparison of Horticultural and Human-Based Terms and Units of Measure

Horticultural	**Photosynthetically Active Radiation (400-700 nm)**	These terms describe the range, in nanometers, of electromagnetic radiation in the most commonly used areas of the spectrum for each type of application.
Human-Based	**Visible Light (380-770 nm)**	
Horticultural	**Photosynthetic Photon Flux (µmol/s)**	These terms describe the total output of light, per second, in the ranges described above. There is no directional information described here. The term "µmol" is an abbreviation for "micromoles", a unit of measure of atomic particles.
Human-Based	**Luminous Flux (lumen)**	
Horticultural	**Spectral Quantum Distribution (µmol/s/nm)**	These terms describe the composition of the light leaving the fixture, by wavelength (in nanometers, or "nm"). There is no time, direction, or intensity information described here – only spectral content. Quantum units are used for horticultural design since plant biology largely depends on delivered *photons*, not watts.
Human-Based	**Spectral Power Distribution (W/nm)**	
Horticultural	**Photosynthetic Photon Flux Density (µmol/s/ft^2, µmol/s/m^2)**	These terms describe the density of light on the area of interest, often called the "task plane". This is often the end goal of the design process, and in general terms, answers the question "How bright will it be?".
Human-Based	**Illuminance (ft-cd, lux)**	
Horticultural	**Photosynthetic Photon Intensity Distribution (µmol/s/sr)**	These terms describe the *direction and intensity* of light leaving the fixture. These allow designers to plan the spacing of fixtures in a facility, and to understand how different light distribution options in fixtures impact the evenness of light in the work area.
Human-Based	**Luminous Intensity Distribution (lm/sr)**	
Horticultural	**Photosynthetic Photon Efficacy (µmol/J)**	These terms describe how efficiently a fixture takes electrical power and converts it to photons in the range of interest.
Human-Based	**Efficacy (lm/W)**	

Would you like to know more?

This document is intended to introduce concepts at a basic level. For more detailed information, please refer to the standards and/or research bodies listed below:

- The American Society of Agricultural and Biological Engineers (ASABE)
- Greenhouse Lighting and Systems Engineering (GLASE)
- The Illuminating Engineering Society (IES)
- Lighting Enabled Systems & Applications (LESA)
- The Lighting Research Center (LRC)
- The Resource Innovation Institute (RII)

Each of these entities has been instrumental in the development of the DLC horticultural lighting requirements, and the DLC looks forward to continued cooperation with all in maximizing the horticultural sector's energy efficiency and productivity.