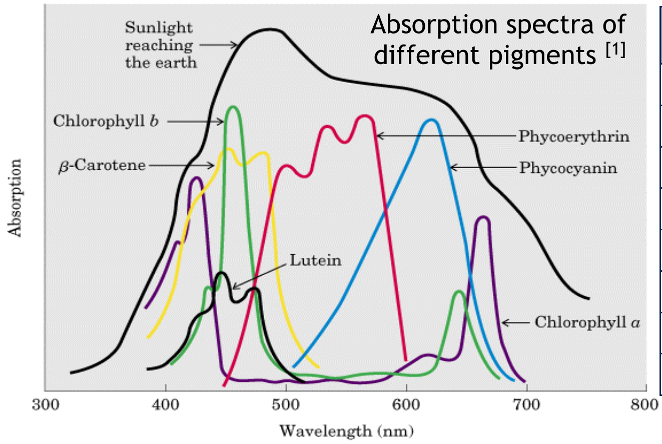
HORTICULTURE LIGHTING BRIEF

Light Recipes for Plants

Horticulture lighting metrics are different than those used for conventional human-centric lighting based on eye response to visible light wavelengths. Plant lighting schemes, however, are based on photosynthesis rates and growth morphology, which depend on the number of incident photons and the wavelengths of light absorbed by plant structures. Key metrics for horticultural lighting are:

- **Photosynthetically Active Radiation** (PAR) – The PAR region is the wavelength range between 400nm to 700nm where photosynthesis occurs due to photon absorption. Other important plant responses that affect growth morphology are driven by light absorption above, below, and within PAR.
- **Photosynthetic Photon Flux** (PPF) – This measures the photosynthetically active photons emitted by a lighting system per second in the PAR wavelength region. This measurement is expressed in micromole per second (μmol/s), the plant equivalent of lumens.
- **Photon Efficacy** – Also referred to as PPF per Watt (PPF/W), a measure of how efficient a horticulture lighting system is at converting electrical energy into photons. This measurement is expressed in micromole per Joule (μmol/J).
- **Photosynthetic Photon Flux Density** (PPFD) – A measurement of the number of photosynthetically active photons that fall on a given surface each second. It is expressed in micromoles per square meter per second ($\mu mol/m^2/s$). This is the plant equivalent of Lux.
- **Day Light Integral** (DLI) – A cumulative measurement of the total number of photons that reach a given surface during the daily photoperiod. DLI is expressed in $mol/m^2/day$. Rule of thumb: 1% increase in DLI translates to 1% increase in plant growth yield.

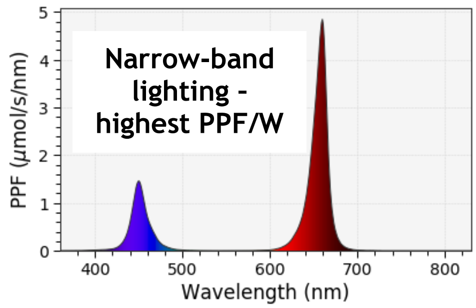
Lighting recipes are used to optimize plant activity during the four growth stages: germination, vegetation, flowering, and fruiting. Different light wavelengths are absorbed by photopigments that control and promote growth. Different light recipes—different wavelength combinations—can be used to achieve more biomass, shorter growth cycle, better taste, and optimal plant size.



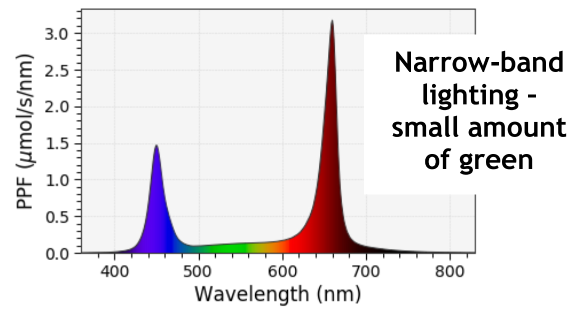
Photopigment Class	Horticultural Functions (Non-inclusive)
Anthocyanins	Nutrient recovery, pollination attractant
Carotenes	Photosynthesis
Chlorophylls	Photosynthesis
Chryptochromes	Circadian rhythms, circannual rhythms
Phototropin	Phototropism
Phytochromes	Photomorphology
URV8	Ultraviolet protection
Xanthophylls	Light energy modulation, photosynthesis

There is no single best solution for all horticultural applications. Different types of plants have different optimal light recipes. Luminus offers LED products with a wide range of light spectrums that can be combined to optimize growth phases.

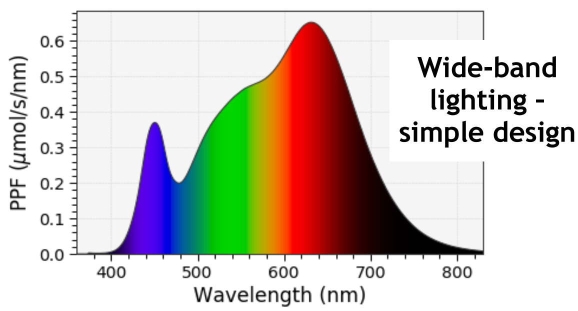
Example Light Recipes using Luminus LEDs



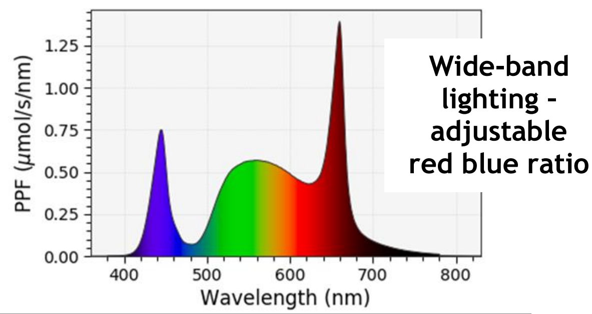
Electrical Power	49 W
PPF	135 umol/s
PPF/W	2.76 umol/J
Appearance	Purple
Recipe	15 SST-10-B (450) 45 SST-10-DR (660)



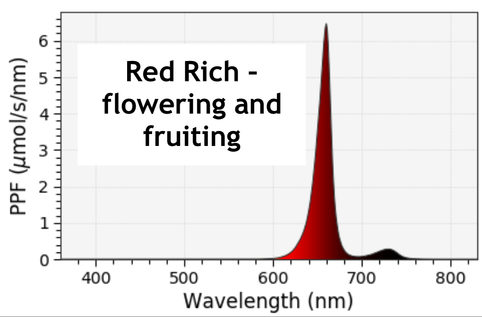
Electrical Power	50 W
PPF	128 umol/s
PPF/W	2.55 umol/J
Appearance	Purple
Recipe	14 SST-10-B (450) 28 SST-10-DR (660) 14 SST20-W40H (4000K)



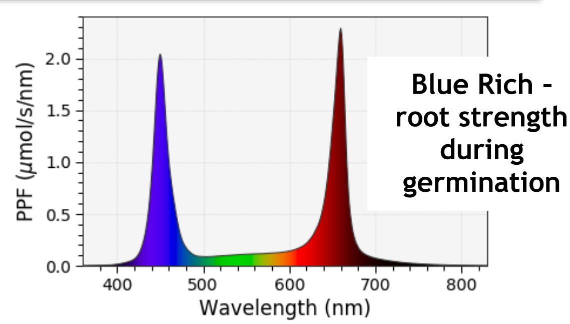
Electrical Power	53 W
PPF	118 umol/s
PPF/W	2.26 umol/J
Appearance	White
Recipe	50 SST20-W40H (4000K)



Electrical Power	50 W
PPF	122 umol/s
PPF/W	2.43 umol/J
Appearance	White
Recipe	11 SST-10-DR (660) 36 SST-20-WxS (5700K) 4 SST20-W40H (4000K)



Electrical Power	48 W
PPF	135 umol/s
PPF/W	2.83 umol/J
Appearance	Red
Recipe	60 SST-10-DR (660) 5 SST-10-FR (720)



Electrical Power	48 W
PPF	118 umol/s
PPF/W	2.45 umol/J
Appearance	Blue
Recipe	12 SST20-W40H (4000K) 20 SST-10-B (450) 20 SST-10-DR (660)

[1] Image from: Raven, G. B. Johnson, K. A., and Mason, S., *Biology*, McGraw Hill (2010).