Light, plants and LED

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Philips Lighting
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innovation + you

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Van der Harg
Pot roses
Netherlands

Why does a plant need light?

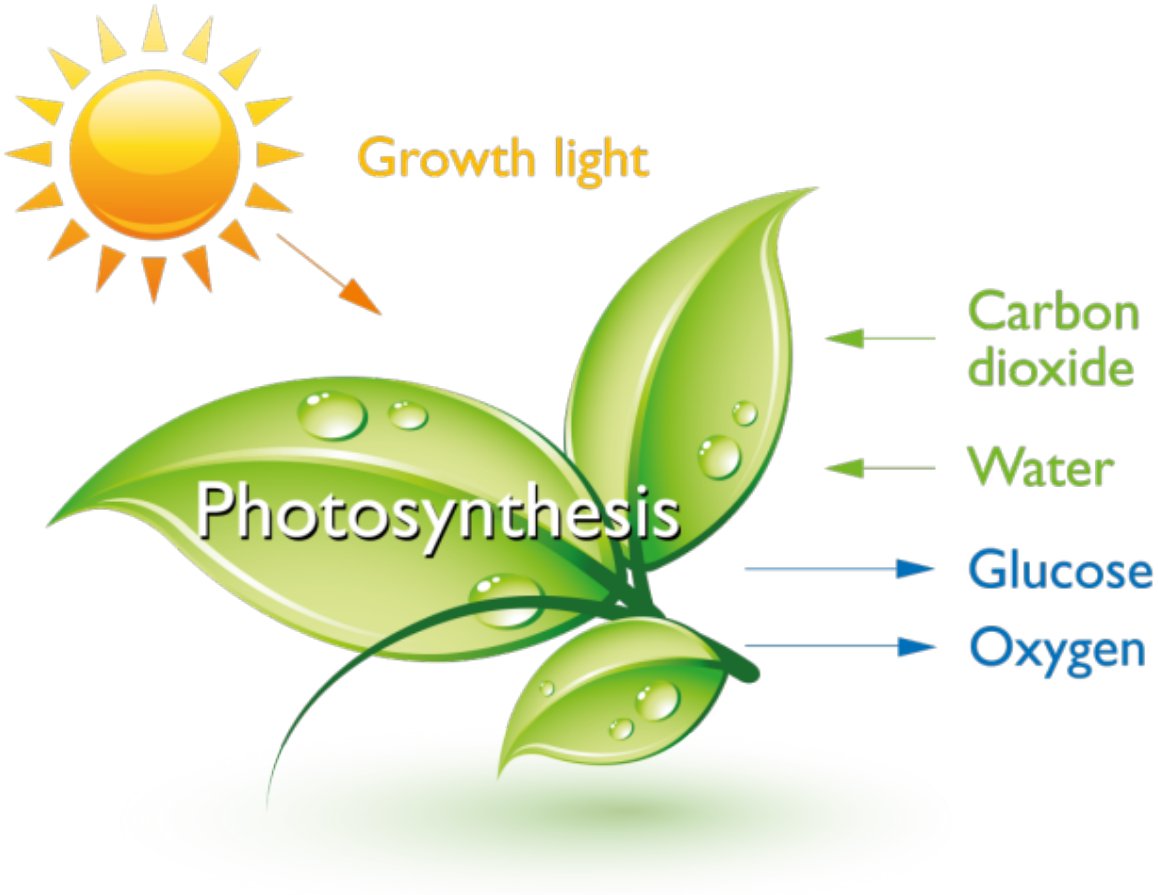
Plants use light for:

1. **Photosynthesis**, growth energy

2. Plant **development**, flowering, morphology etc.

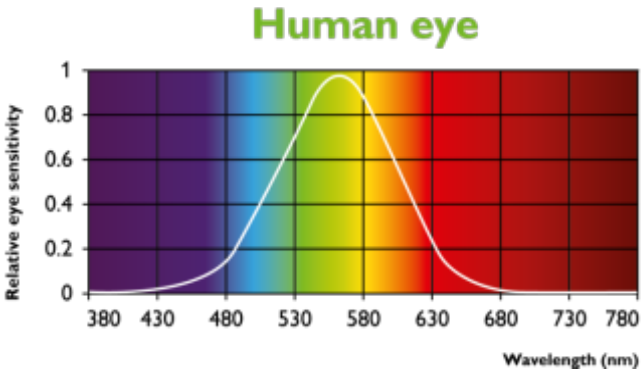
Both simultaneously take place in the plant and interact with each other.

A plant needs light to grow: photosynthesis



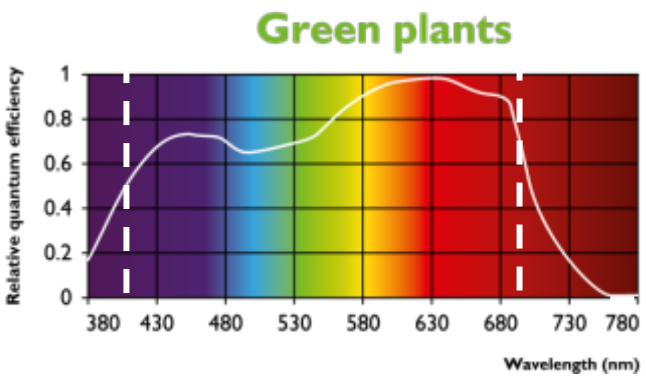
Photons are absorbed by pigments in the plant (e.g. chlorophyll). Carbon dioxide and water are converted to glucose, which is an energy source for the plant.

Quantifying light for plants



Metric is based on the human eye sensitivity curve.

Lumen is a measure of the total amount of visible light emitted by a source.
Lux (=lumen/m^2) is a measure of the amount of light per surface area.



Metric is based on the photosynthesis of plants. Photosynthetically active radiation (PAR): 400 - 700 nm.

Photosynthetic Photon Flux (**PPF**), in **Micromole/s** is # photons in 400-700nm range.
Photosynthetic Flux Density (**PPFD**) is a measure of the amount of PAR per surface area, expressed in **Micromole/m^2/s**.
Daily Light integral: **Mole/m^2/day**.

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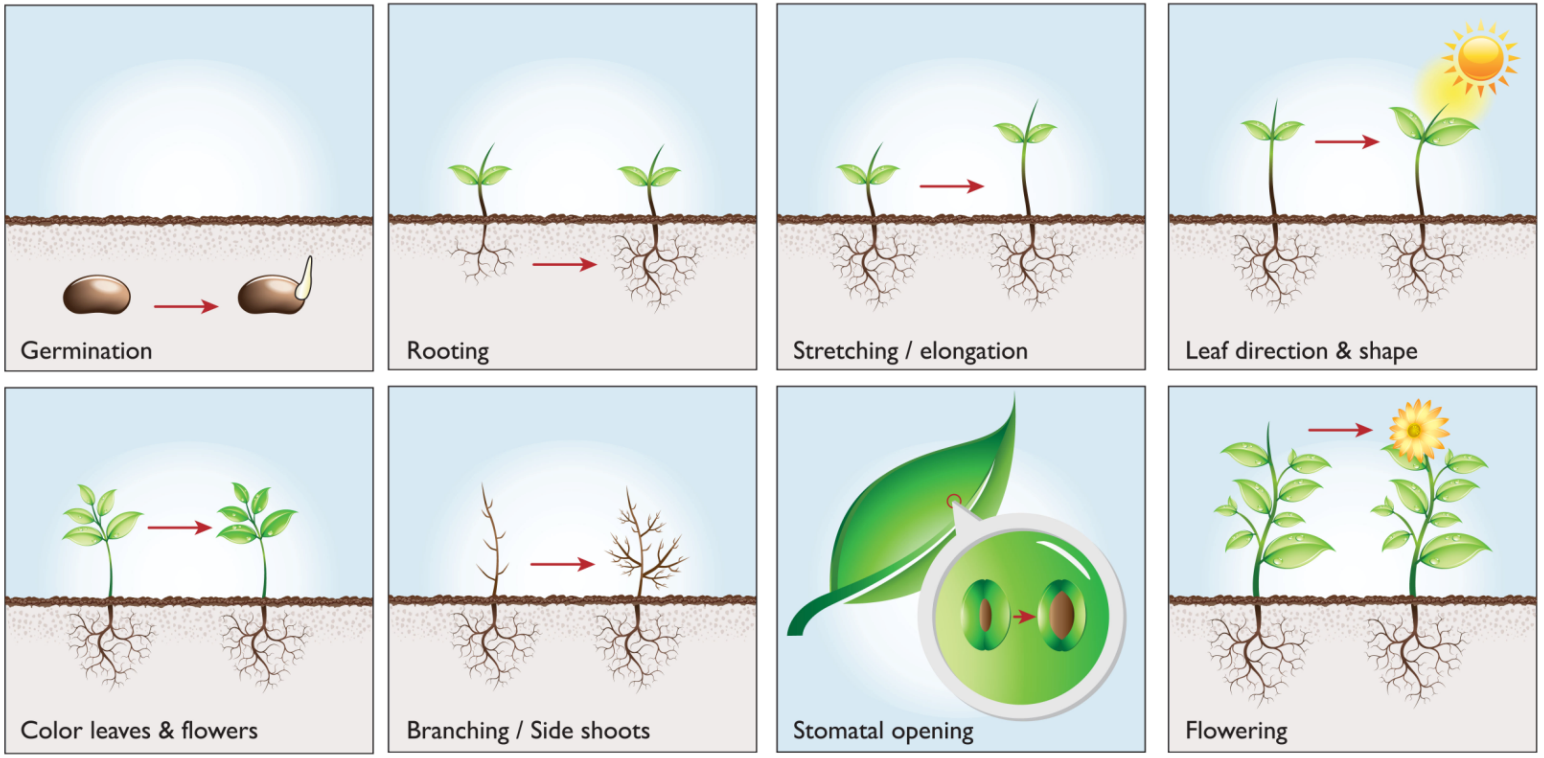
A plant needs light to develop: morphology

Light also stimulates specific plant processes and morphology



Receptors playing an important role in these processes are Cryptochromes, Phytochromes and Phototropin

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Plants use light for development

Plants have several **photoreceptors** that respond to different wavelengths. These photoreceptors trigger plant development responses.

RECEPTOR	UVR8	Cryptochromes Phototropins	Phytochromes
	UV defense mechanisms	Stomatal opening Phototropism Adapting to light intensity Anthocyanin formation	Flowering of SD & LD plants Shade avoidance response - Elongation, no branching - Flowering

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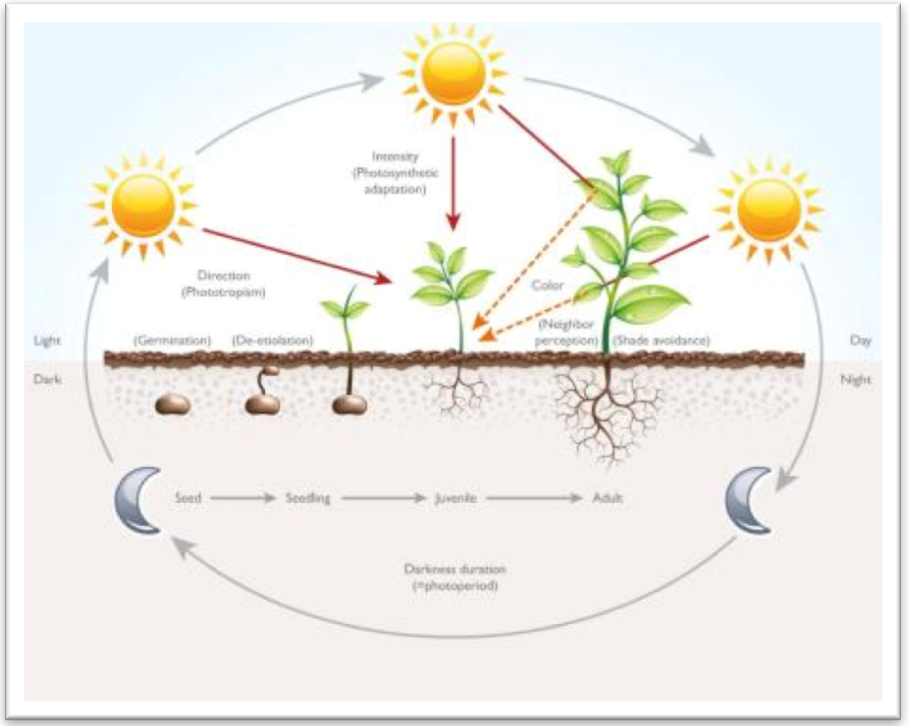
Light characteristics influence plants over life

Key factors influencing both plant growth and development:

- Light intensity
- Light/dark duration (photoperiod)
- Light spectrum (light quality)

} Light sum over time (DLI)



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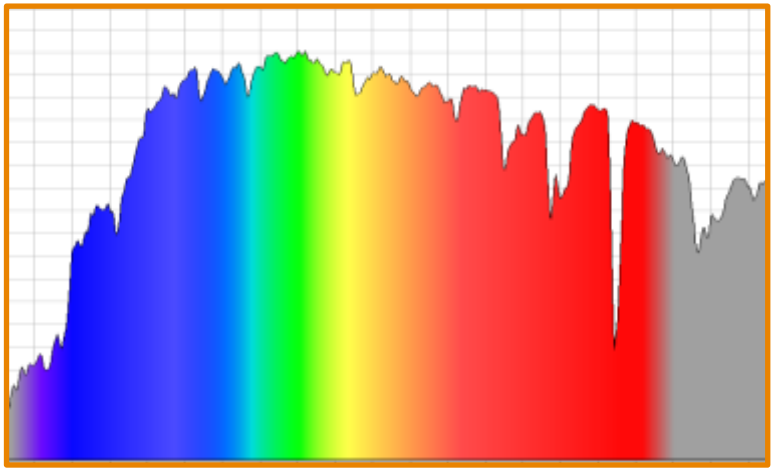
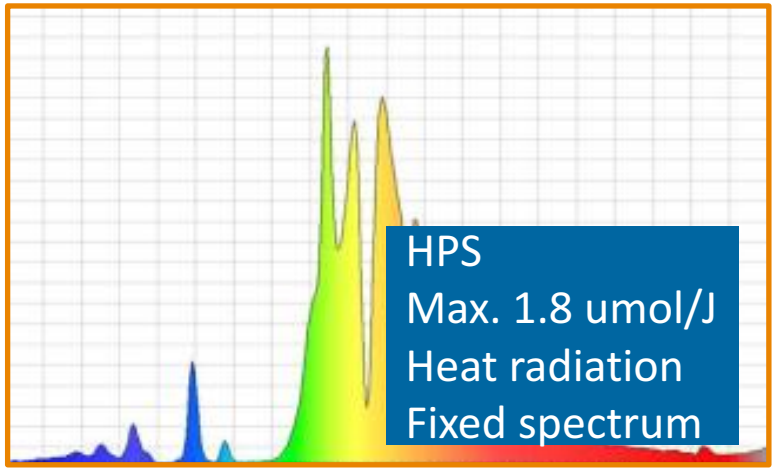
Spectra of sunlight vs HPS vs LED

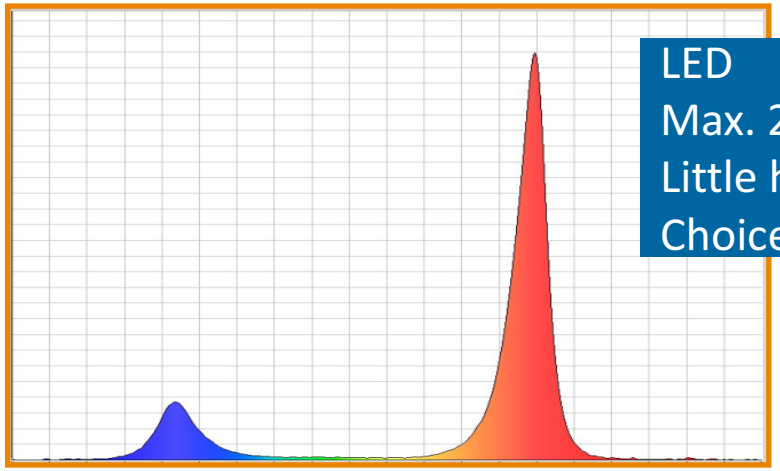
Sunlight



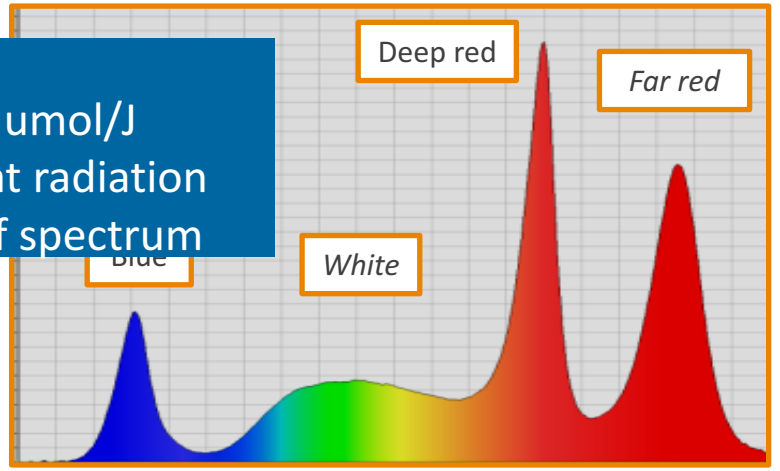
HPS



B/DR LED



DB/W/R/FR LED



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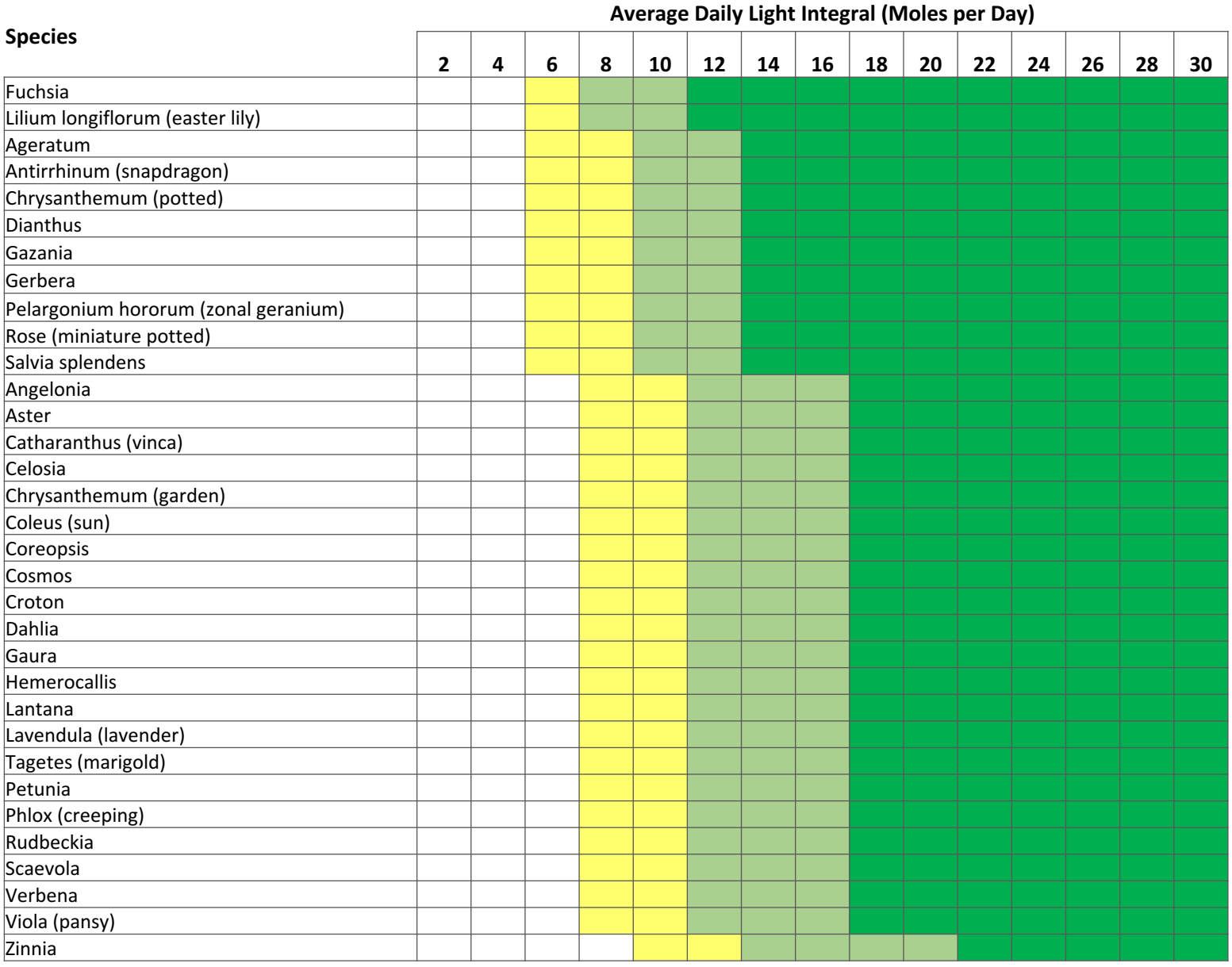
Recommended Daily Light Integrals



Source:
Measuring Daily Light Integral in a Greenhouse; Ariana P. Torres and Roberto G. Lopez

*See additional species on published report

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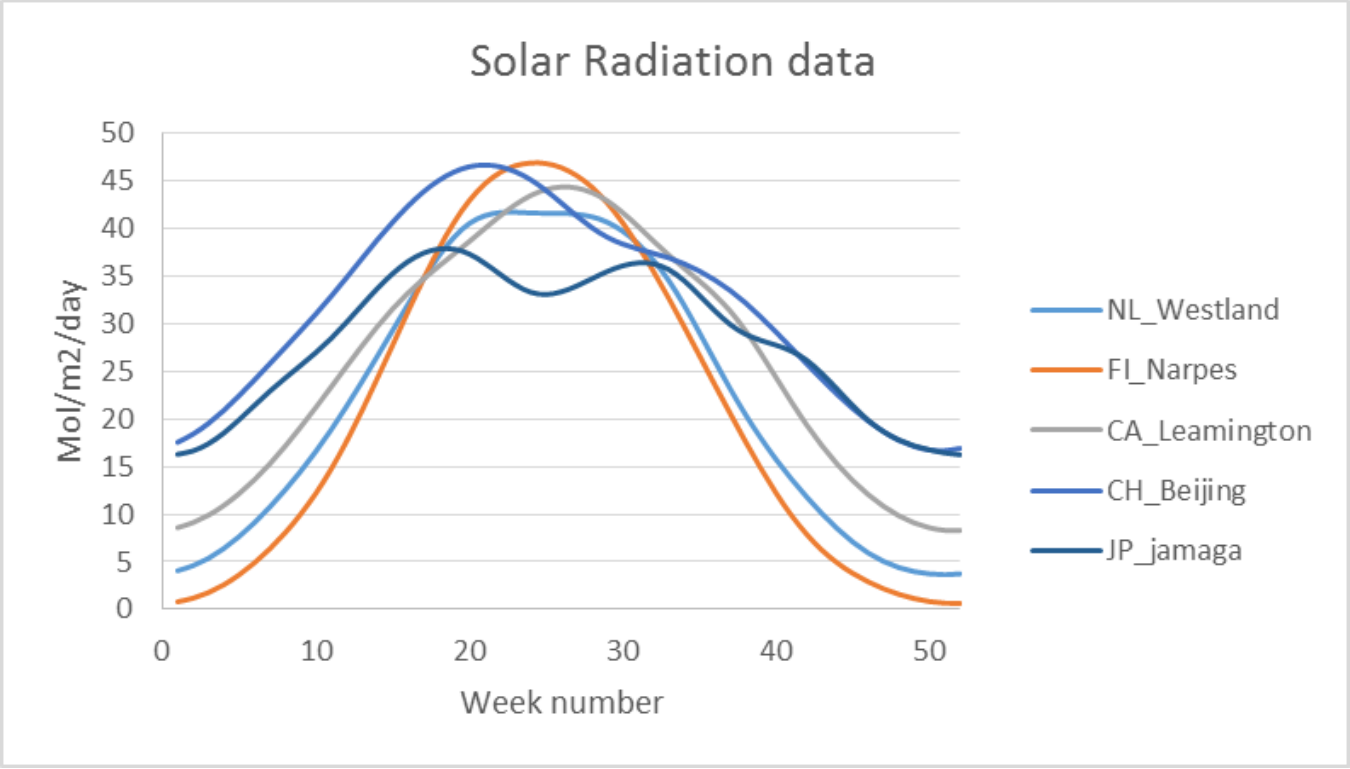
Natural light for different locations

- **Geography** has big impact on the variation in daylight between summer/winter
- **Greenhouse transmission** determines what fraction of natural light reaches plants



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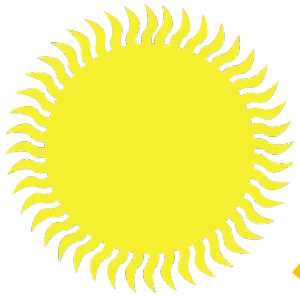
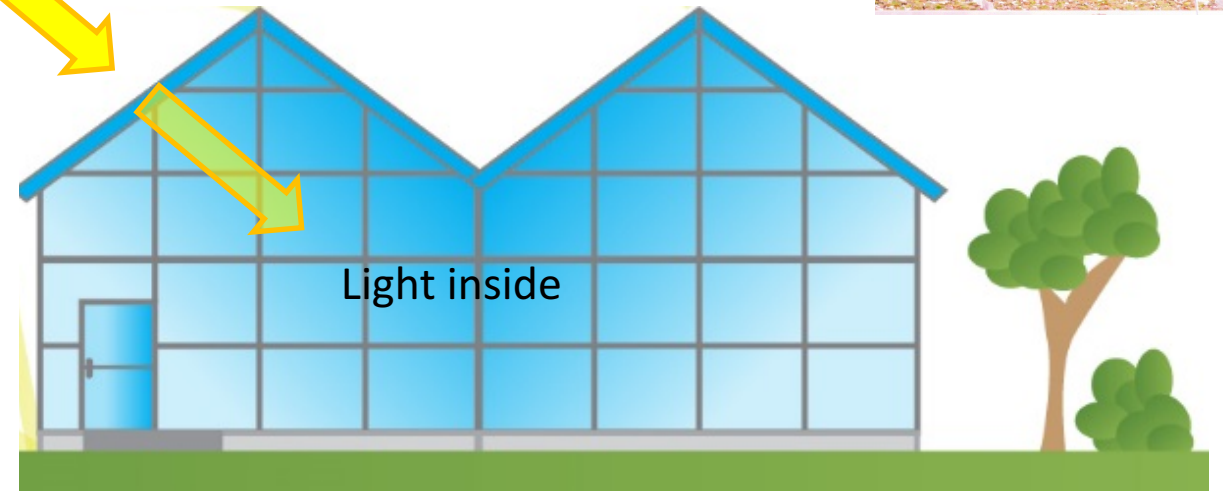
Greenhouse transmission



Light outside



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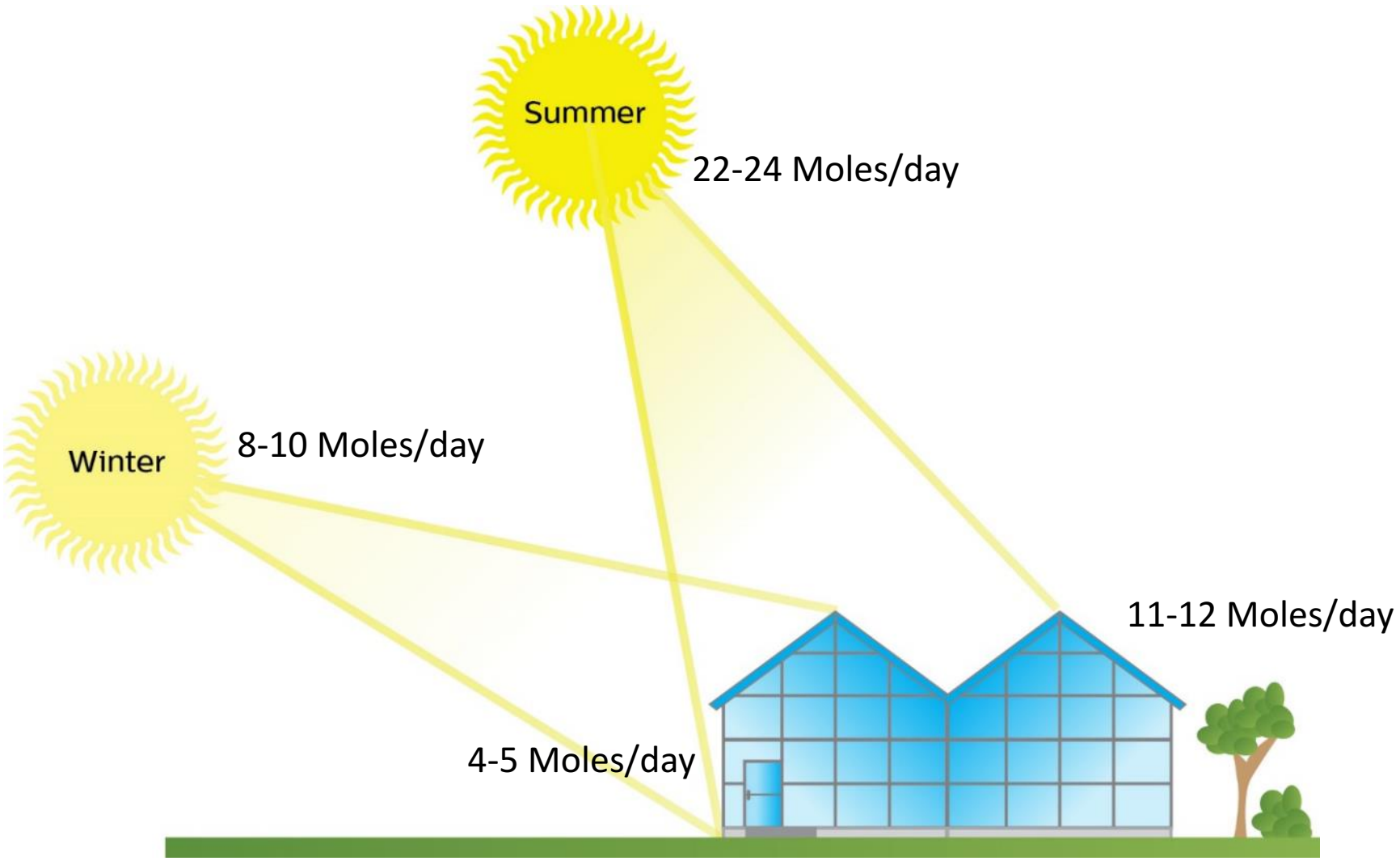
Example light levels in Michigan, US



[1]Source: *Measuring Daily Light Integral in a Greenhouse*
Ariana P. Torres and Roberto G. Lopez; Department of Horticulture and Landscape Architecture, Purdue University

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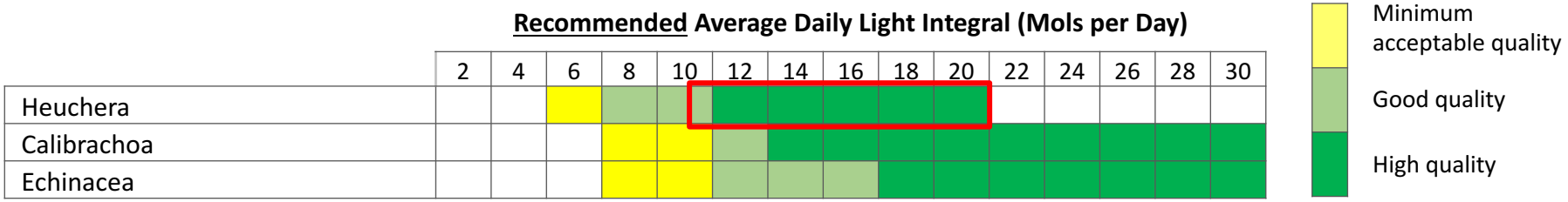
Determining supplemental lighting needs



Crop

- Recommended DLI for high quality crop
- Light inside greenhouse
- Light deficiency = target

Heuchera

12 Mol/day

5 Mol/day

7 Mol/day

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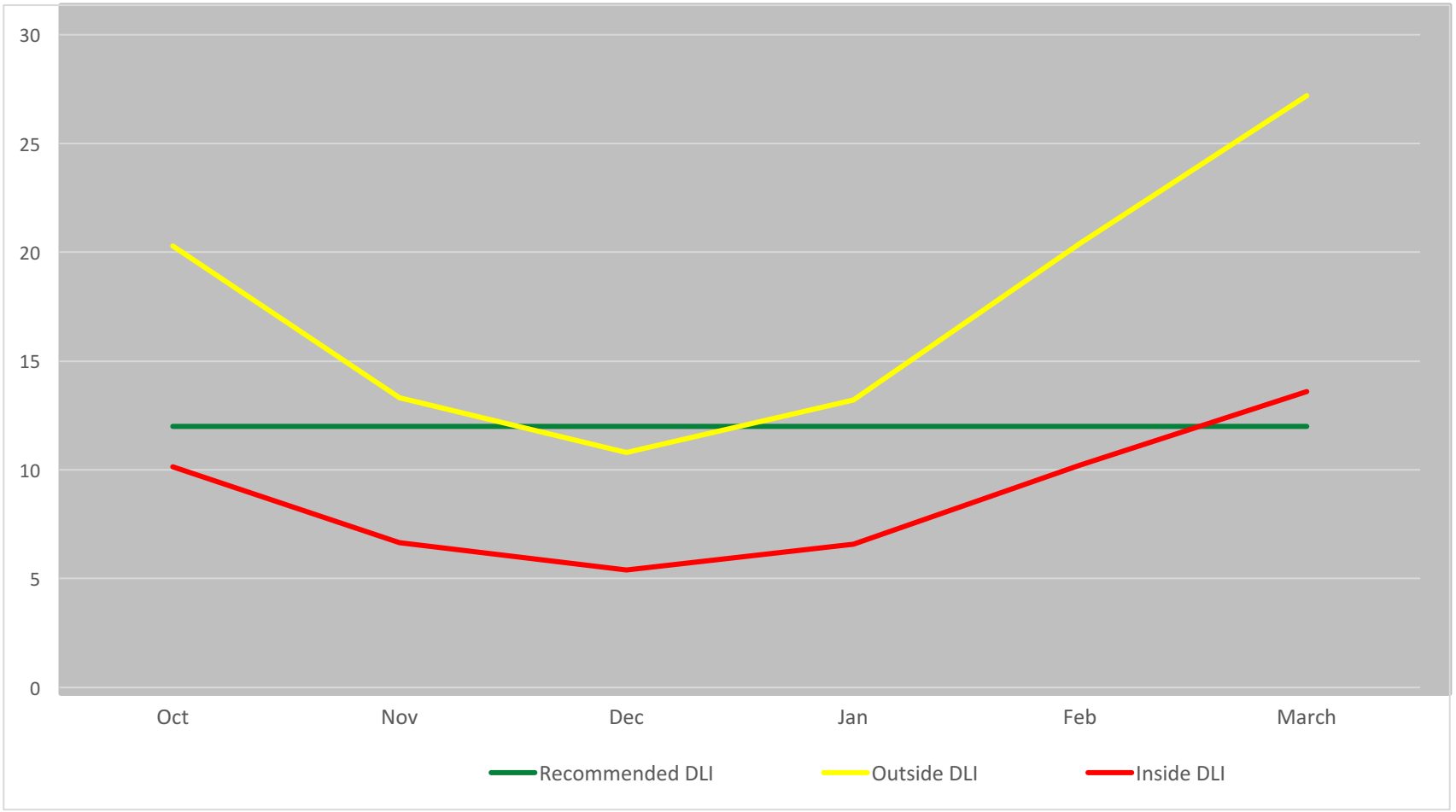
Natural light vs recommended DLI, Michigan



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Geranium

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Begonia

Petunia

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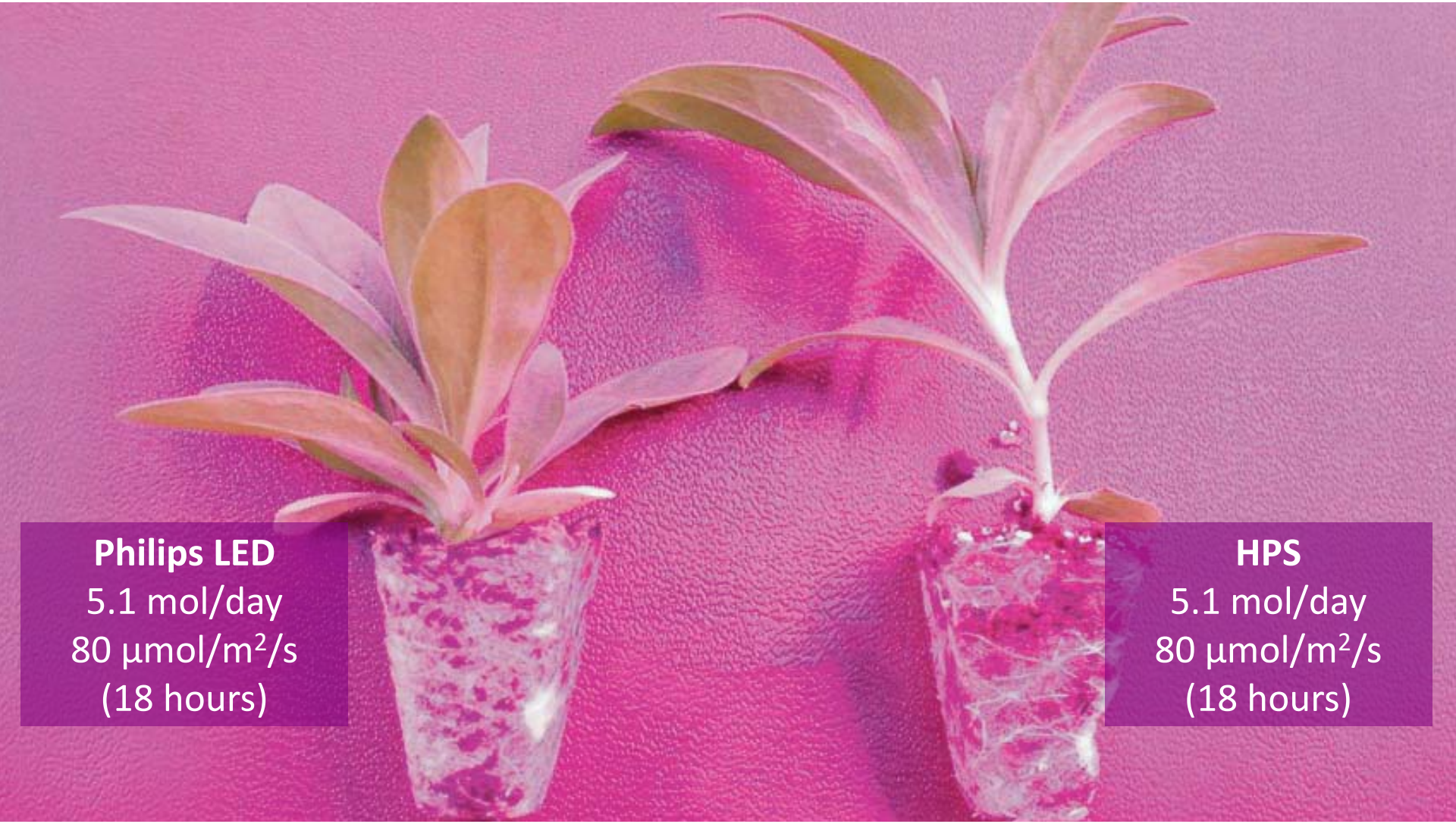
Dianthus



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Promising results of LED for young plant production

- Compact plugs
- More basal vegetative bud development
- Better root development
- Reduction in the cycle time (seeding till transplant)
- Improved % of plugs ready for transplanting
- Prominent leaf pigmentation
- Early and increased % flowering

Leo van der Harg (Netherlands)

- LED Toplight + 1000W HPS

"Because LEDs do not generate any radiant heat, it is possible to control the temperature and the lighting separately."

- Leo van der Harg, Manager

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Iwasaki Bros., Inc. (Oregon, US)

"We've **shortened our crop cycle by up to three weeks**, which means we can get an extra cycle of plants through a greenhouse and that's very exciting, very profitable."

- Jim Iwasaki, Owner and Manager

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Rudy Raes, Belgium

Higher yield with lower energy cost.
From 50 µmol/m^2/s HPS
to 65 µmol/m^2/s LED

"The uniformity and quality of our crops has increased. LED gets us stronger rooting."

- Rudy Raes, Owner Rudy Raes Bloemzaden NV

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Growth like never before!


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