

## Essentials of Hydroponics Production a tHRive Symposium

July, 2023







OptimIA



Lighting Approaches to Maximize Profits







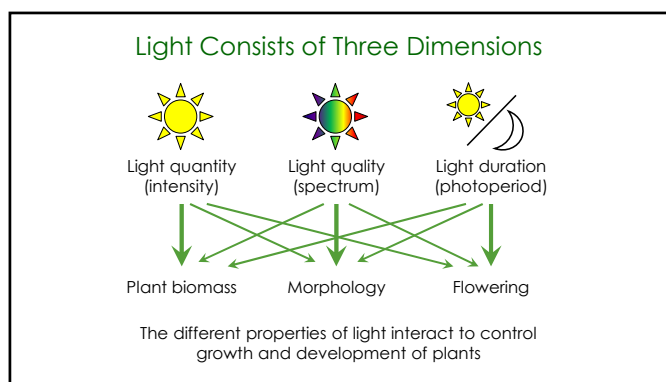
### Agenda

8:00 am	Welcome and Speaker Introductions	Erik Runkle (Michigan St.)
8:05 am	The Basics Of Plant Lighting	Erik Runkle (Michigan St.)
8:25 am	Supplemental Lighting Technology For Crop Production	A.J. Both (Rutgers)
8:45 am	Plant Responses To The Environment	Roberto Lopez (Michigan St.)
9:05 am	Basics Of Heating, Ventilation, & Air Conditioning (HVAC)	Nadia Sabeih (Dr. Greenhouse)
9:25 am	Break	
9:35 am	An Introduction To Hydroponics Systems	Murat Kacira (Arizona)
9:55 am	Nutrient & Rootzone Management	Chieri Kubota (Ohio St.)
10:15 am	Crop Production Methods For Leafy Greens	Celina Gomez (Purdue)
10:35 am	Q&A and Discussion	

## The Basics of Plant Lighting

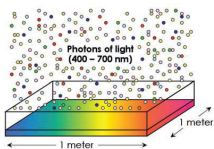


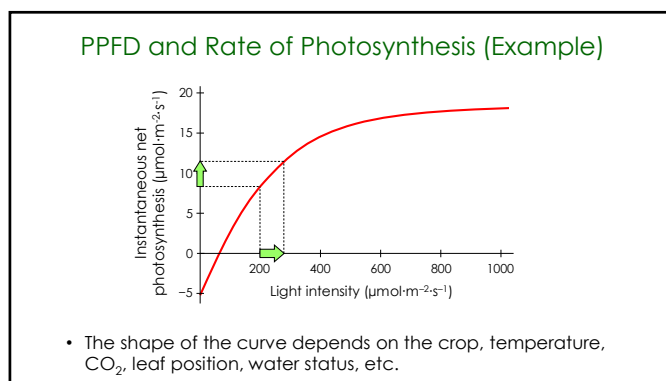
**Erik Runkle**  
Professor of Horticulture  
Michigan State University

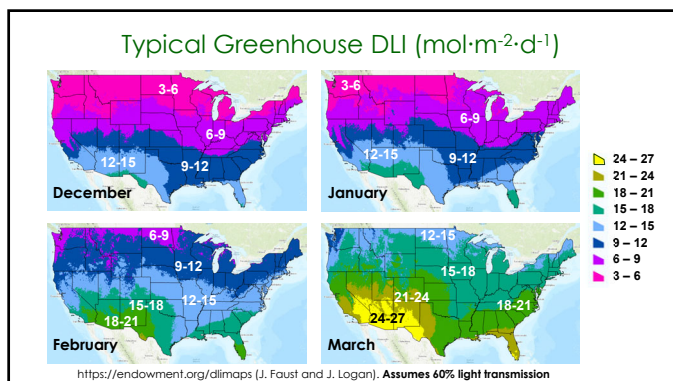


### Quantity of Light: Instantaneous and Daily

- We measure light intensity based on the number (mol) of particles of light (photons) received per square meter (m<sup>2</sup>) and second (s) or day (d)
- Instantaneous:** Photosynthetic photon flux density (PPFD) – the flux density of photons with wavelengths between 400-700 nm ( $\mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$ )
- Daily:** The daily light integral (DLI) describes this cumulative number of those photons (400-700 nm) per square meter in one day ( $\text{mol}\cdot\text{m}^{-2}\cdot\text{d}^{-1}$ )







### How Much Lighting Do You Need?

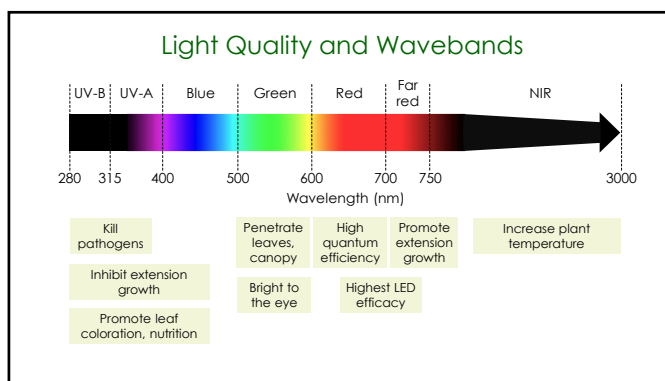
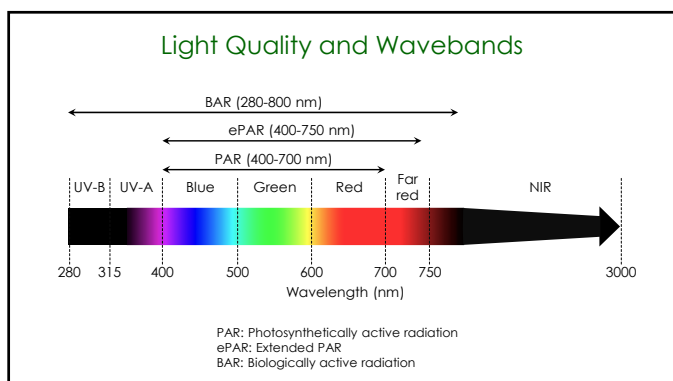
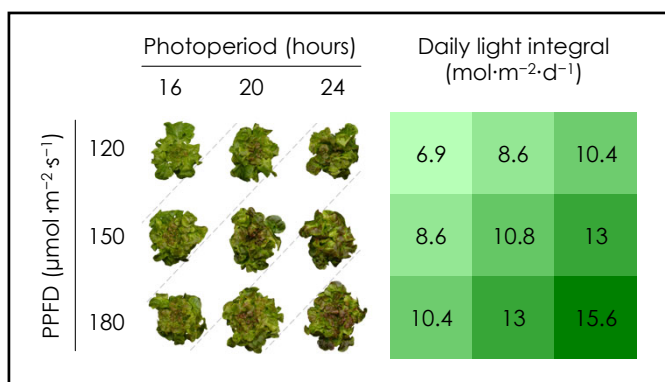
- Highly situational depending on what you receive from the sun (if any), crop, and desired quality/yield
- Intensity (PPFD) needed: Desired DLI – Solar DLI

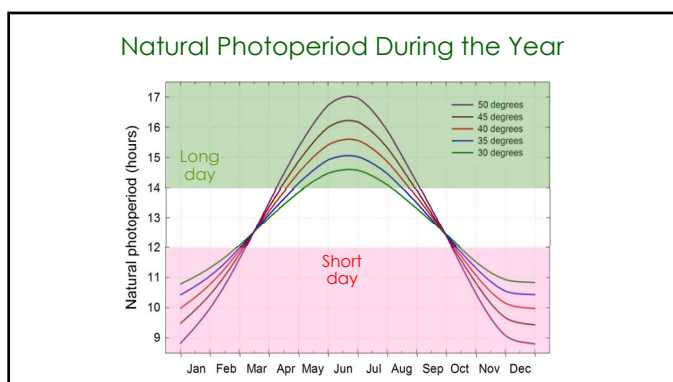
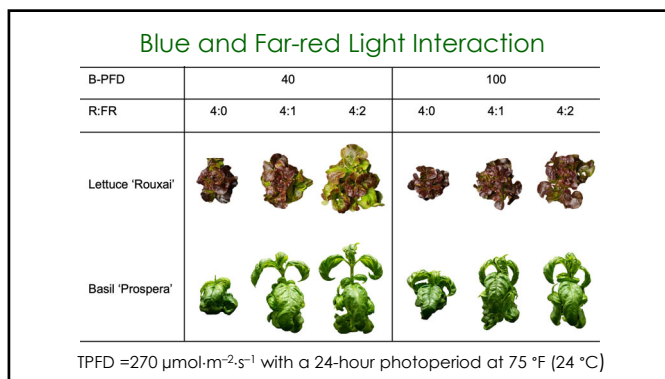
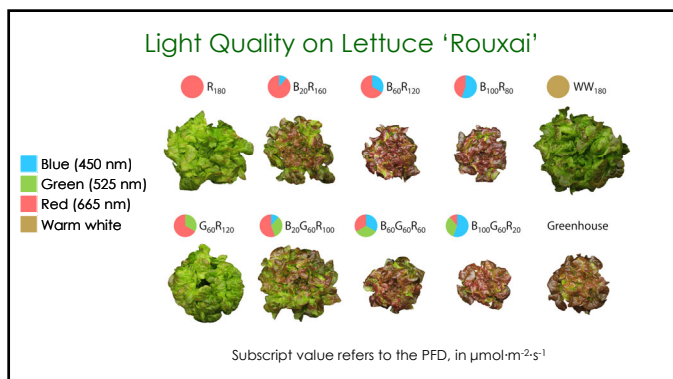
Hours per day	PPFD (μmol·m <sup>-2</sup> ·s <sup>-1</sup> )						
	50	75	100	150	200	300	500
	Daily light integral (mol·m <sup>-2</sup> ·d <sup>-1</sup> )						
8	1.4	2.2	2.9	4.3	5.8	8.6	14.4
12	2.2	3.2	4.3	6.5	8.6	13.0	21.6
16	2.9	4.3	5.8	8.6	11.5	17.3	28.8
20	3.6	5.4	7.2	10.8	14.4	21.6	36.0

### General Plant Responses to DLI

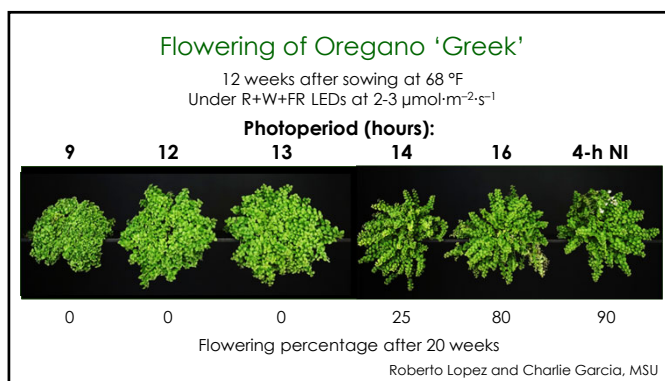
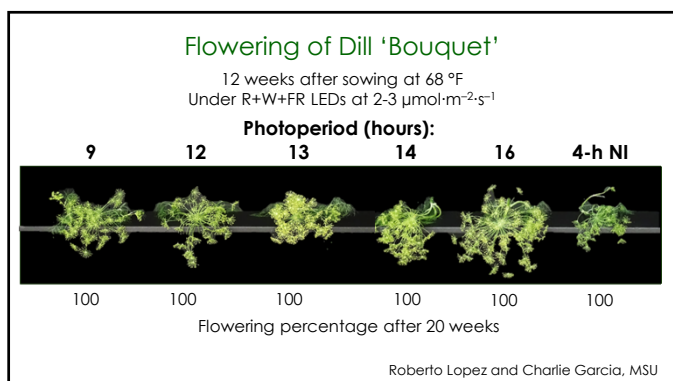
- Leaves (smaller and thicker)
- Branching (increased)
- Stem diameter (increased)
- Root growth (increased)
- Time to flower (faster, due partly to temperature)
- Harvestable yield (leaves, flowers, or fruit) (increased)
- Quality (increased)

Low DLI      High DLI





- ### Photoperiodic Flowering Responses
- Day neutral: Flowering is not influenced by photoperiod
  - Short-day plants: Flowering is faster or only occurs under short days (less than 12-13 hours)
  - Long-day plants: Flowering is faster or only occurs under long days (usually more than 13-15 hours)
  - Long-day lighting: Provide at least  $1-2 \mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$  at the end of the day or during the middle of the night for up to 4 hours



### Photoperiodic Responses of Herbs & Vegetables

Short-day plants	Day-neutral plants	Long-day plants
American basil (F)	Basil	Arugula (F or O)
Stevia (O)	Cinnamon basil	Cilantro (O)
Sweet potato (O)	Cucumber	Dill (F or O)
	Oregano	Greek oregano (O)
	Pepper	Lemon thyme (F)
	Tomato	Lettuce (F)
		Peppermint (O)
		Spearmint (O)
		Spinach (O)
		Sweet marjoram (O)

F = facultative response; hastens but is not required for flowering  
O = obligate response, requires photoperiod for flowering

### Photoperiodic Lighting



### Horticultural Lighting Applications

	Greenhouse		Indoors
	Photoperiodic	Supplemental	Sole-Source
Use or objective	Promote or inhibit flowering	Increase growth, harvestable yield, and plant quality	Indoor production to regulate growth and product consistency
Plants targeted	Photoperiodic crops	Young plants and high-value crops	Leafy greens, herbs, young plants, cannabis
Typical intensity ( $\mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$ )	1-2	60-100 ornamentals 100-250 vegetables	150-250 most crops (higher for cannabis)
When used	During the night, Sept. to Mar.	During the night and on cloudy days, Sept. to Mar.	Every day
Number of hours used per day	Usually up to 4	Usually up to 18-20	12-24