





## Effects of Increasing Light Quantity on Greenhouse Crops

Roberto Lopez 




## Review of Light Concepts

- Light is a form of energy referred to as electromagnetic radiation.
- Therefore light can vary in:
  - Duration (photoperiod),
  - Quality (color and wavelength), and
  - **Quantity or Intensity (quantity of light at each wavelength or color)**




## Review of Light Concepts

- Light quantity is the number of light particles (called photons) capable of performing photosynthesis
- Plants growth is driven by photosynthesis, which converts water, carbon dioxide, and energy from light into carbohydrates
- Less than half of the energy (43%) from the sun is in the photosynthetically active radiation (PAR) range of 400 to 700 nm




## Review of Light Concepts

- Increasing energy in the PAR range, up to an optimal light intensity maximizes photosynthesis, plant growth, and quality
- Greenhouse growers can increase energy in the PAR range by increasing the daily light integral (DLI)



## Methods to Increase DLI

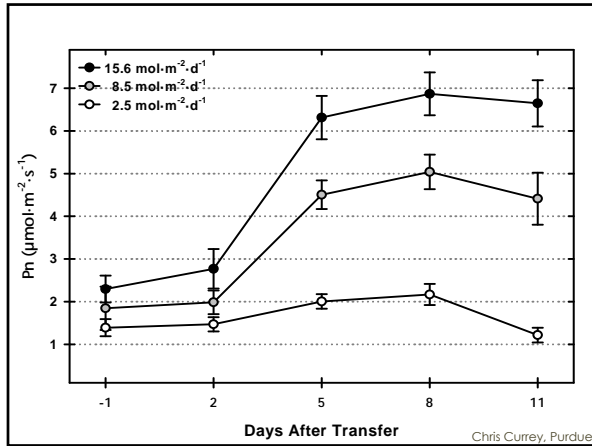
- Minimize overhead obstructions such as hanging baskets
- Make sure glazing is properly cleaned (ie. whitewash, dust, algae removed)
- Provide supplemental lighting from high pressure sodium lamps (HPS), metal halide (MH) or light emitting diodes (LEDs)



## Plant Responses to Higher DLI

- Increased photosynthesis
- Smaller and thicker leaves
- More and larger flowers
- Reduced time to flower (partly due to temperature)
- Increased branching
- Increased stem diameter
- Increased root growth of plugs and cuttings

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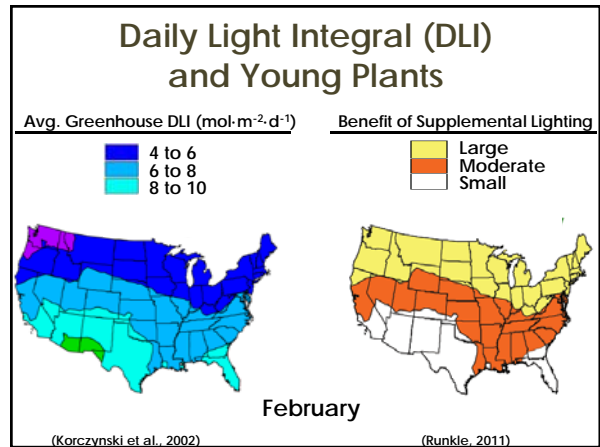
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### Effects of Providing Supplemental Light during Plug Production (Seedlings)

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### DLI and Young Plants

- During seed and vegetative cutting propagation, the DLI outdoors can range from 5 to 20 mol·m<sup>-2</sup>·d<sup>-1</sup> across the northern U.S.
- In greenhouses, light levels can be 50% or less of that outdoors because of structures, glazing, shading, and obstructions
- Therefore, the DLI during propagation can be as low as 2 to 10 mol·m<sup>-2</sup>·d<sup>-1</sup> and even lower during extended periods of cloudy weather



### Supplemental Lighting of Plugs Research conducted at Michigan State University

- The seedling stage was divided into thirds, each lasting 9 or 11 days
- Plugs were placed under HPS lights for 1/3 or 2/3 of the plug stage, not at all, or during the entire period.

	1st	2nd	3rd
L-L-L	Low DLI		
H-L-L	High DLI		
L-H-L			
L-L-H			
H-H-L			
L-H-H			
H-H-H			

Sowing → Emergence → Transplant

- Petunia: 27 days
- Pansy: 33 days

Erik Runkle, Michigan State Univ.

### Petunia 'Madness Red'

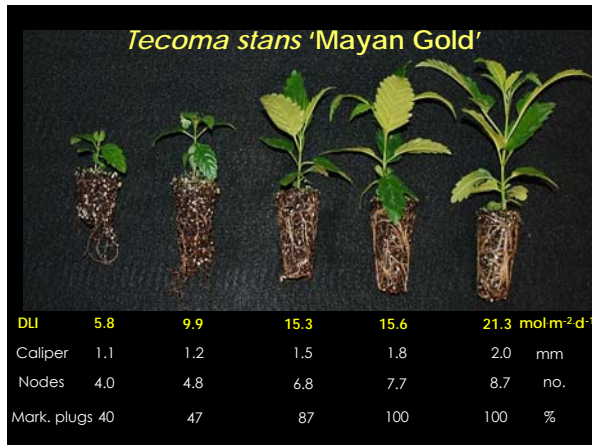
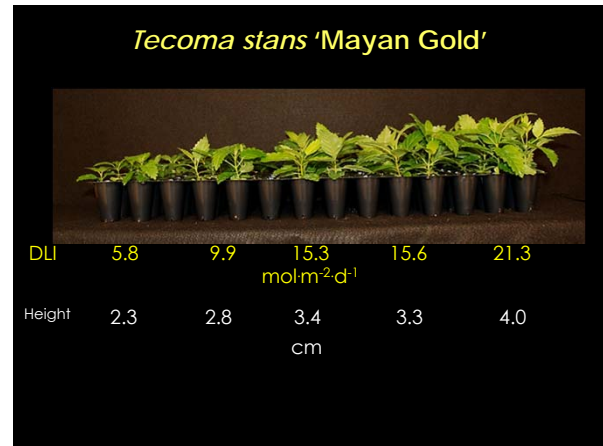
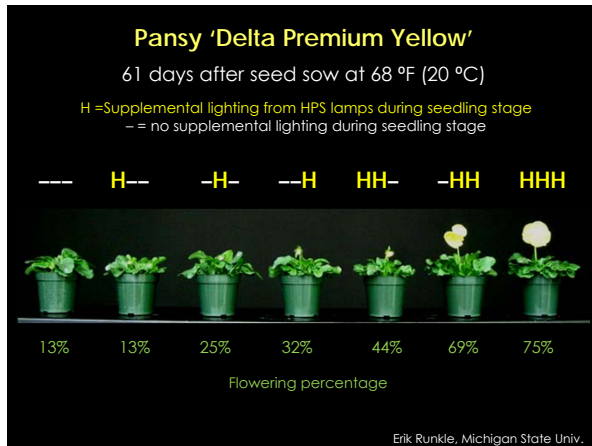
27 or 33 days after seed sow at 68 °F (20 °C)

H = Supplemental lighting from HPS lamps  
- = no supplemental lighting

--- H-- -H- --H HH- -HH HHH

### Pansy 'Delta Premium Yellow'

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### Supplemental Lighting of Plugs

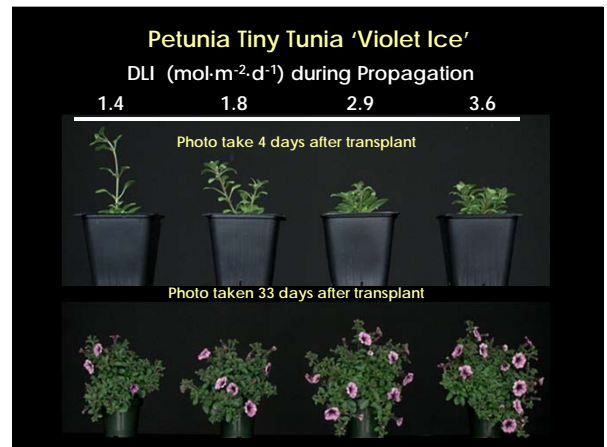
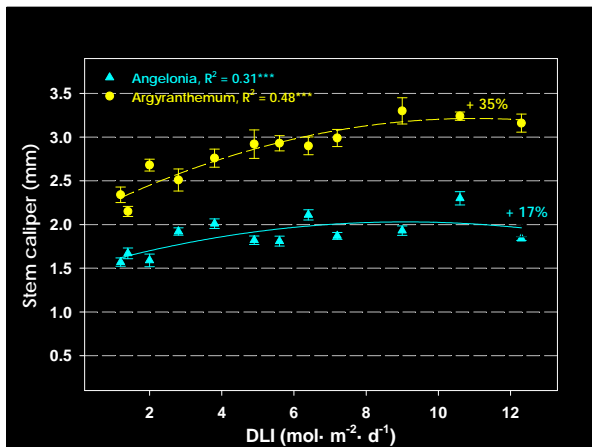
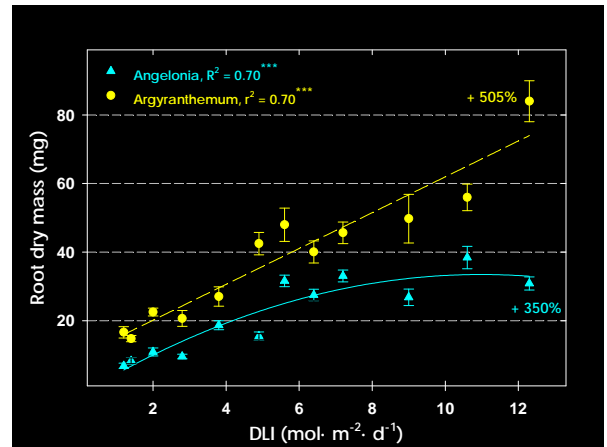
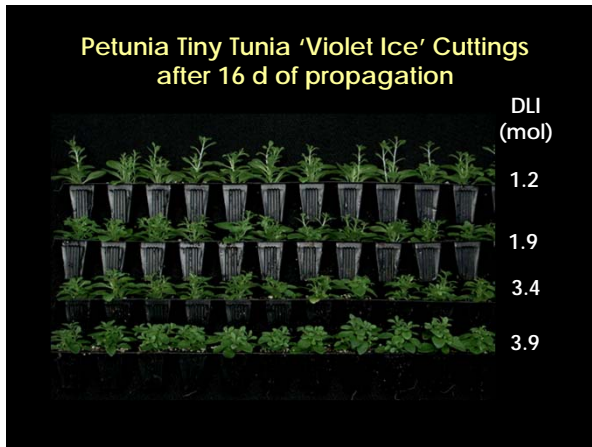
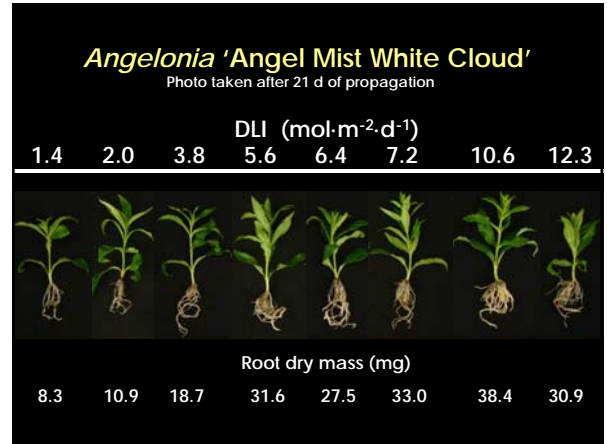
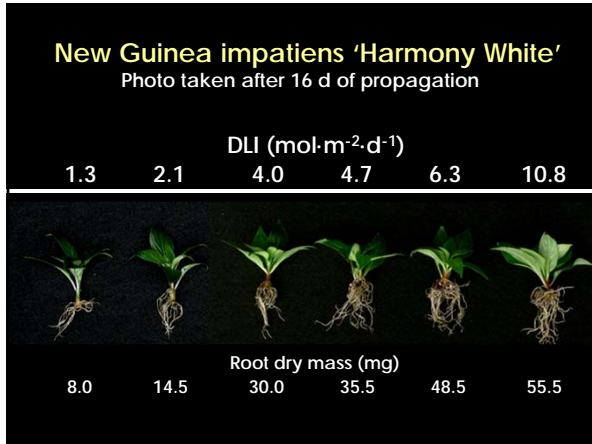
- When light is limiting (<10 mol·m<sup>-2</sup>·d<sup>-1</sup>), supplemental lighting is recommended
  - Most beneficial during the later stages of plug production
  - The highest-quality plugs are those grown under constant supplemental lighting
- Bedding plant seedlings provided with higher DLI will typically flower earlier than seedlings that are not provided with higher DLI



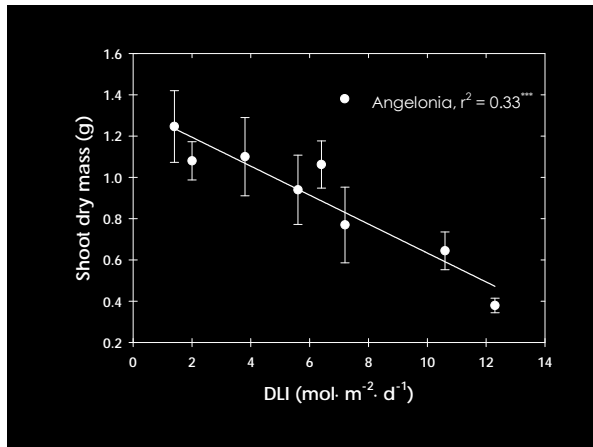
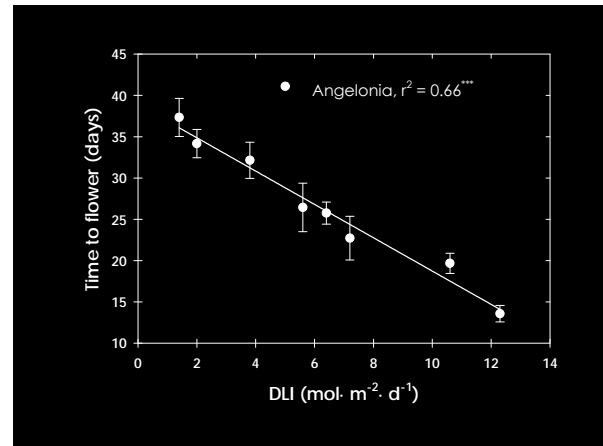
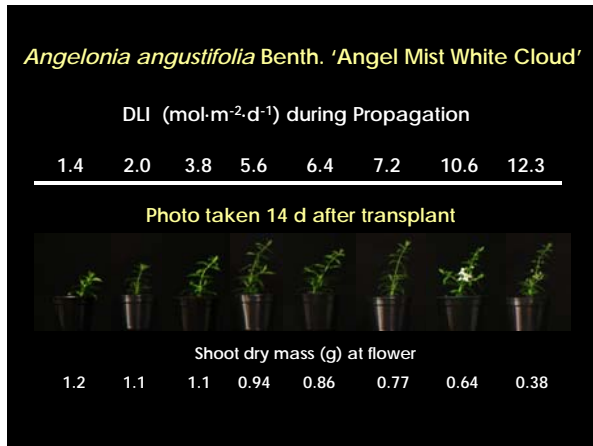
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### Effects of Providing Supplemental Light during Liner Production (Cuttings)

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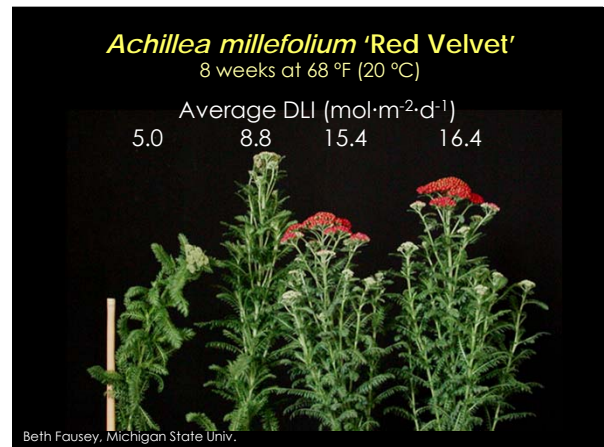
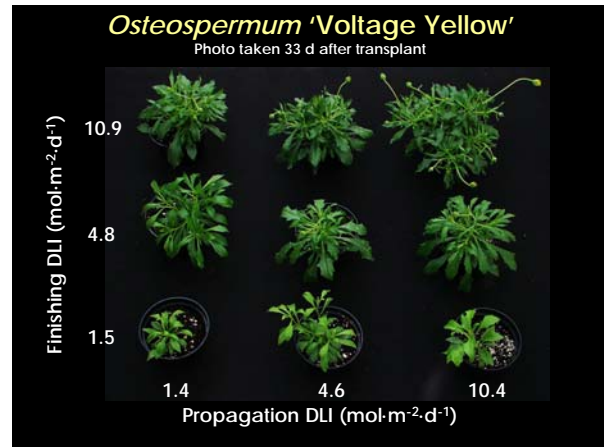
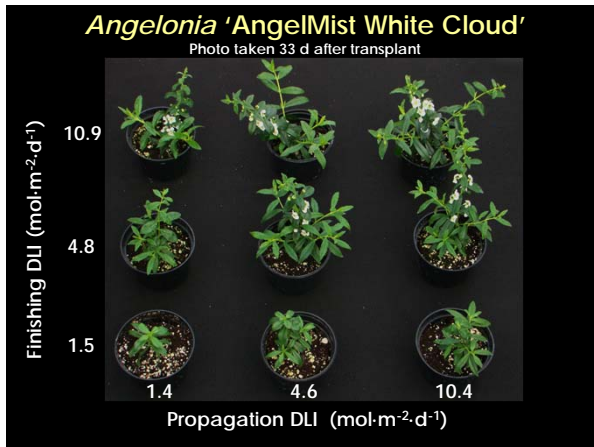
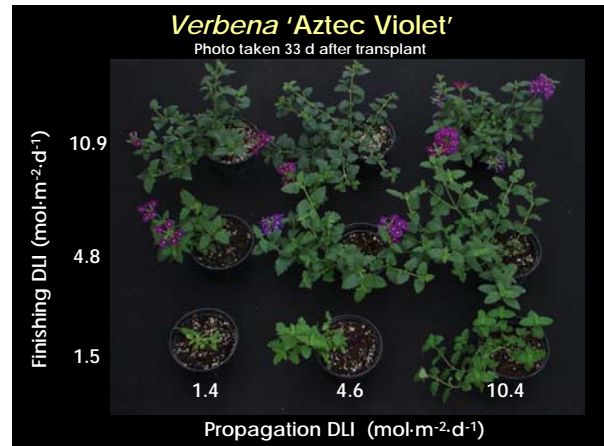
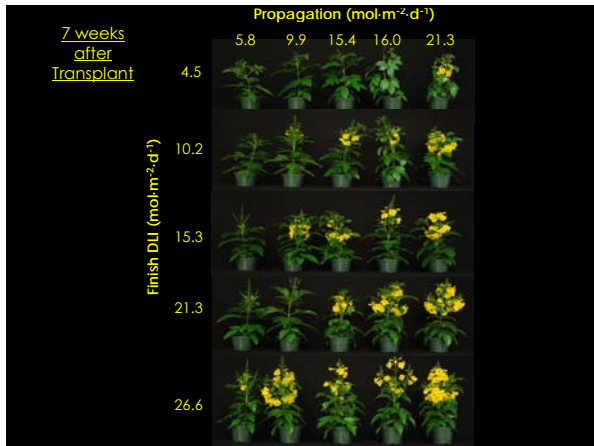
### Supplemental Lighting of Cuttings

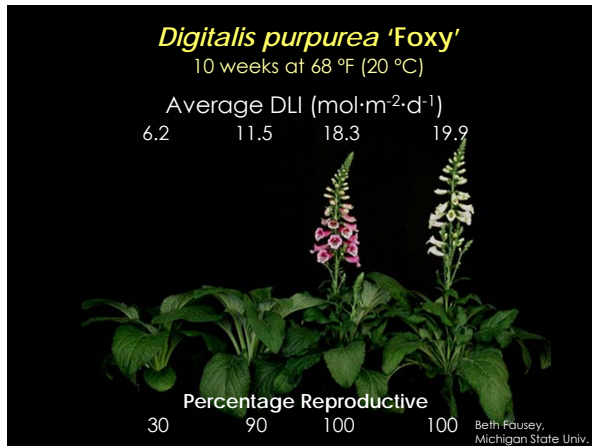
- When light is limiting ( $<10 \text{ mol}\cdot\text{m}^{-2}\cdot\text{d}^{-1}$ ), supplemental lighting is recommended
  - Most beneficial during the rooting and toning stages of cutting propagation
  - The highest-quality liners are those grown under supplemental lighting
- Bedding plant cuttings provided with higher DLI will typically flower earlier than cuttings that are not provided with higher DLI

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### Effects of Providing Supplemental Light during the Young Plant and Finish Stages

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### Supplemental Lighting of Finish Crops

- During finishing, crops can be divided into DLI requirements:
  - Low-light crops provide 3 to 6  $\text{mol}\cdot\text{m}^{-2}\cdot\text{d}^{-1}$
  - Medium-light crops provide 6 to 12  $\text{mol}\cdot\text{m}^{-2}\cdot\text{d}^{-1}$
  - High-light crops provide 12 to 18  $\text{mol}\cdot\text{m}^{-2}\cdot\text{d}^{-1}$
  - Very highlight crops provide >18  $\text{mol}\cdot\text{m}^{-2}\cdot\text{d}^{-1}$
- A common target minimum DLI inside a greenhouse is 10 to 12  $\text{mol}\cdot\text{m}^{-2}\cdot\text{d}^{-1}$  for medium to high-light crops

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### Take Home Message

- Increasing DLI:
  - maximizes photosynthesis, plant growth and quality
- Supplemental lighting is recommended when DLI is limiting ( $<10 \text{ mol}\cdot\text{m}^{-2}\cdot\text{d}^{-1}$ )
  - Plugs
  - Cuttings
  - Most finish crops

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### More Information on DLI

Visit: [flowers.hort.purdue.edu](http://flowers.hort.purdue.edu)

- Click on the Extension bulletin tab

The collage includes bulletins such as 'Commercial Greenhouse Production', 'Measuring Daily Light Integral in a Greenhouse', and 'Measuring Daily Light Integral (DLI)'. It features images of greenhouses, light meters, and plants.