Comparison of Light Qualities and DLI for Sole-source Lighting of Microgreens and Bedding Plant Plugs

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Two Major Studies

- Study 1 – Microgreens
- Study 2 - Bedding plant plugs
- Both studies looking at sole-source lighting using LEDs
  - Quality (color or distribution)
  - Quantity (DLI)

Background

- Vegetables and herbs consumed at young stage (first set of true leaves)
- Food enhancement
  - Color
  - Flavor
  - Texture
- Health promoting
- High market value

Objective

- Quantify the effects of sole-source (SS) LED lighting providing different light intensities and qualities on: growth, morphology, and nutritional content of *Brassica* microgreens

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Materials and Methods

Plant Material

- *Brassica oleracea* var. *gongylodes* (kohlrabi)
- *Brassica juncea* (mustard)
- *Brassica rapa* spp. nipposinica (mizuna)

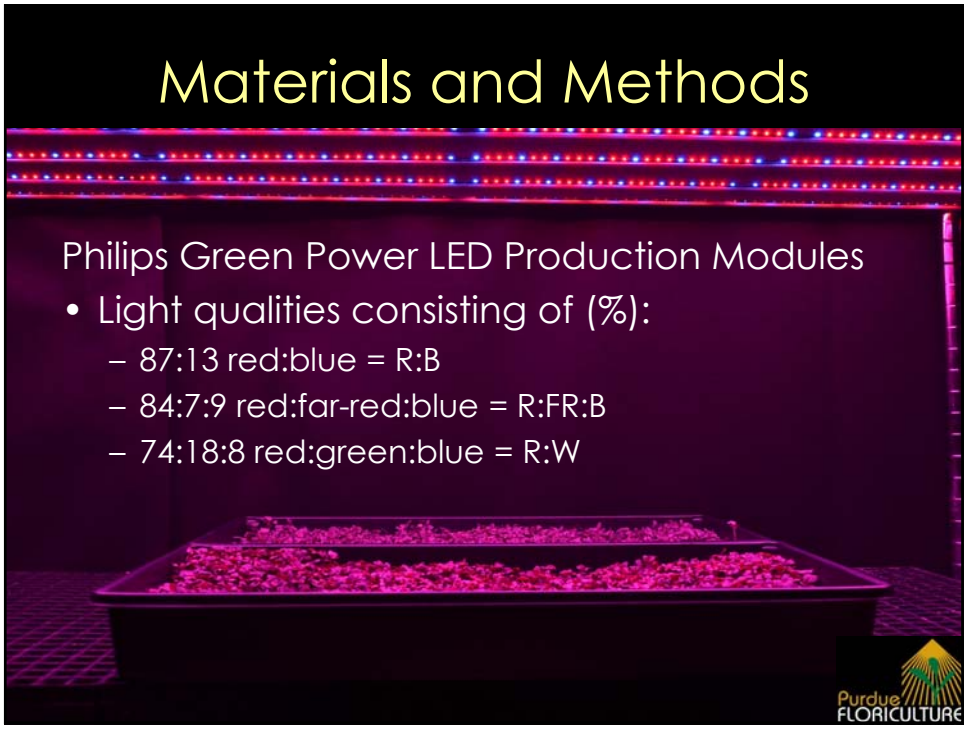
Walk-in Environmental Chamber

- 16-h photoperiod
- 70/63 °F (21/17 °C) day/night (16 h/8 h)
- 50/60% day/night relative humidity
- 500 ppm CO_2

Materials and Methods

Substrate and Fertilization

- Polyethylene terephthalate fiber pad hydroponic tray
- 300 mL of a 25% Hoagland's #1 nutrient solution added to each tray daily


Materials and Methods
Philips Green Power LED Production Modules
• Light qualities consisting of (%):
– 87:13 red:blue = R:B
– 84:7:9 red:far-red:blue = R:FR:B
– 74:18:8 red:green:blue = R:W
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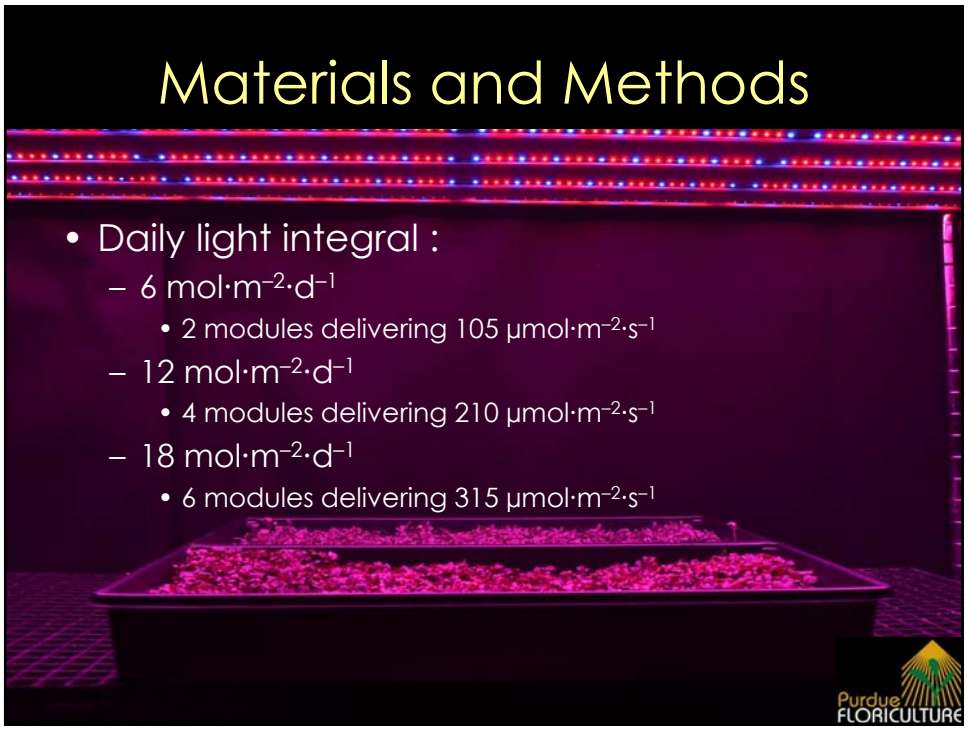
Materials and Methods
• Daily light integral :
– 6 mol·m^{-2}·d^{-1}
• 2 modules delivering 105 µmol·m^{-2}·s^{-1}
– 12 mol·m^{-2}·d^{-1}
• 4 modules delivering 210 µmol·m^{-2}·s^{-1}
– 18 mol·m^{-2}·d^{-1}
• 6 modules delivering 315 µmol·m^{-2}·s^{-1}
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Materials and Methods

- Data collected
  - Hypocotyl elongation
  - Leaf area
  - Dry weight
  - Carotenoids
  - Anthocyanin
  - Phenolics
  - Macro- and micronutrients

- Study repeated twice

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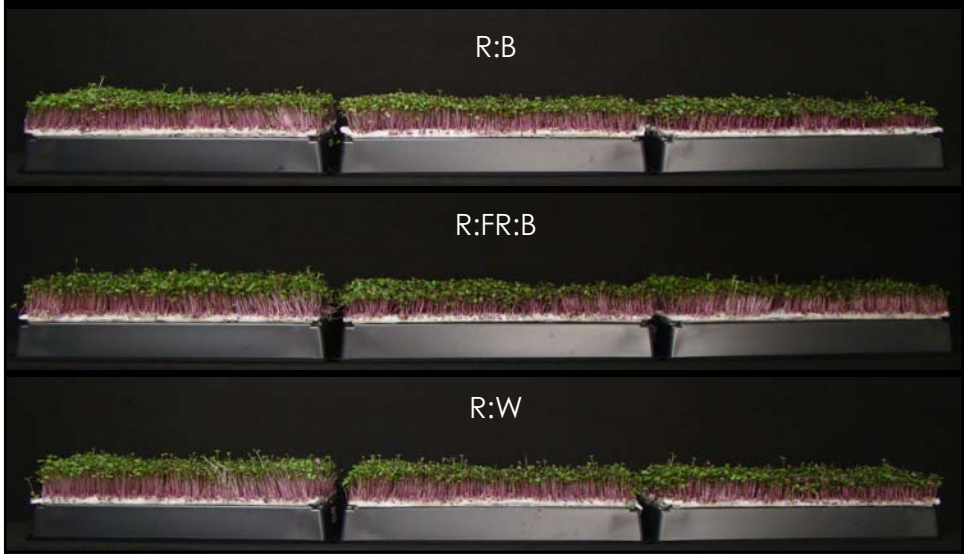
Results - Kohlrabi

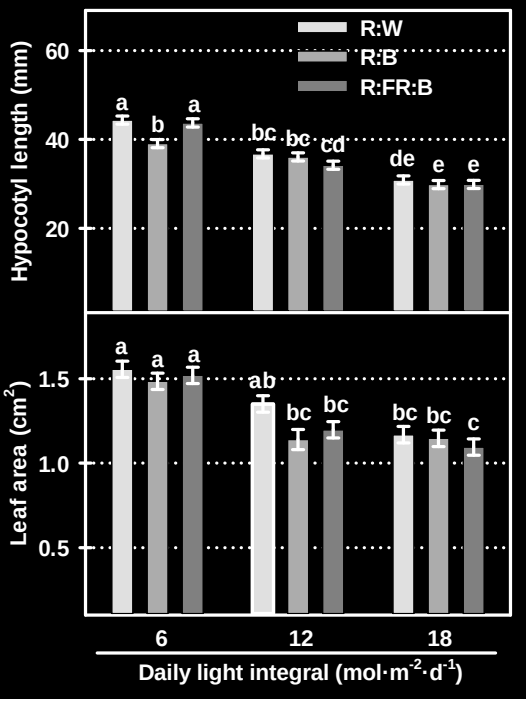
DLI (mol·m^{-2}·d^{-1})

6 12 18



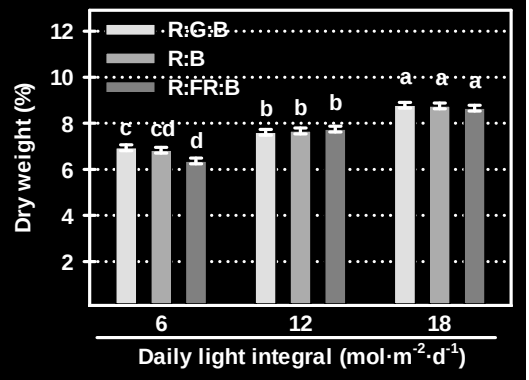
Results - Kohlrabi

- Hypocotyl length
  - Decrease with increasing DLI
  - Quality effect at low DLI
- Leaf area
  - Decrease with increasing DLI



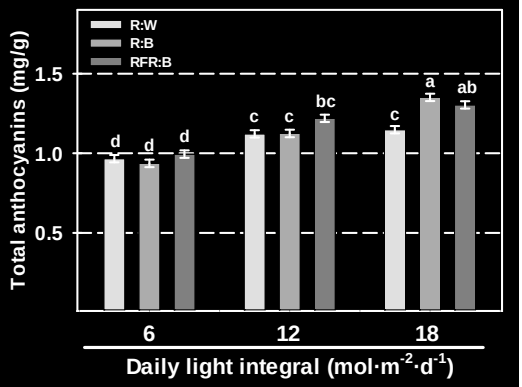
Results - Kohlrabi

- Dry weight
  - Increase as the DLI increases
  - More total biomass but smaller leaf area

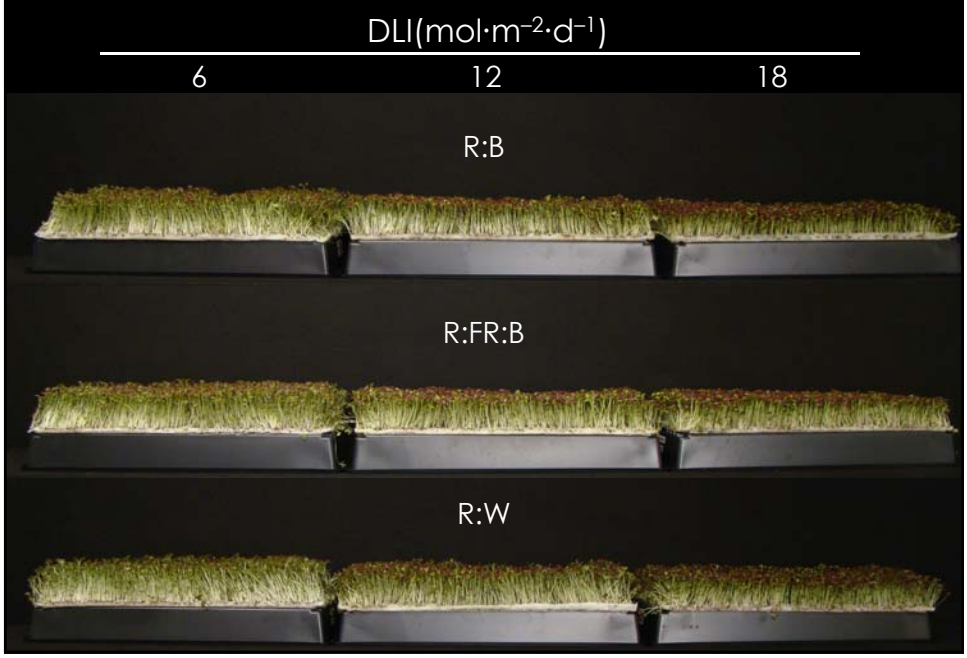


Results - Kohlrabi

- Total anthocyanins
  - Increase as DLI increases
  - Lower levels under R:W and DLI of 18
    - Antagonistic effect of green light
    - Reverse accumulation from blue light



Results - *Brassica juncea* (mustard)



Energy Usage

Light Quality (%)	Daily light integral (mol·m^{-2}·d^{-1})		
	6	12	18
	Killowatt hours per day (kWh·d^{-1})		
R:B	1.03 ± 0.02	2.06 ± 0.03	3.10 ± 0.05
R:W	1.02 ± 0.04	2.04 ± 0.08	3.06 ± 0.12
R:FR:B	1.03 ± 0.04	2.06 ± 0.07	3.09 ± 0.11

Conclusions

- Growth and Morphology
  - Biomass production increased under higher light intensities
  - Leaf area decreased under higher light intensities
  - Hypocotyl length decreased as DLI increased
- Increased DLI led to increased anthocyanin content
- Electrical savings are greatest with low light intensities

Light Quality and Quantity from Sole-source LEDs Influences Growth and Subsequent Flowering of Bedding Plant Plugs

Background

- Quality seedling
  - Compact
  - Stem caliper
  - Dry mass
- Delay in flowering for some plants when produced under LED sole-source red:blue lighting

Hypothesis and Objectives

Hypothesis: Young LD plants grown under LED sole-source lighting providing far-red (FR) light will flower earlier

Objectives:

- Quantify effect of FR light on seedling quality and subsequent time to flower
- Quantify effect of DLI on seedling quality and subsequent time to flower

Materials and Methods

Environment and Culture

- 70 °F (21°C) constant air temperature
- 70/80% day/night relative humidity (16 h/8 h)
- 16-h photoperiod
- 500 ppm CO_2
- 288-cell plug tray
- Fertilized with 100 ppm N Jack's LX Plug Formula for High Alkalinity Water

Materials and Methods

- Three light quality treatments
  - R:B
  - R:FR:B
  - R:W
- Three DLI treatments
  - 6 mol·m^{-2}·d^{-1}
  - 12 mol·m^{-2}·d^{-1}
  - 18 mol·m^{-2}·d^{-1}

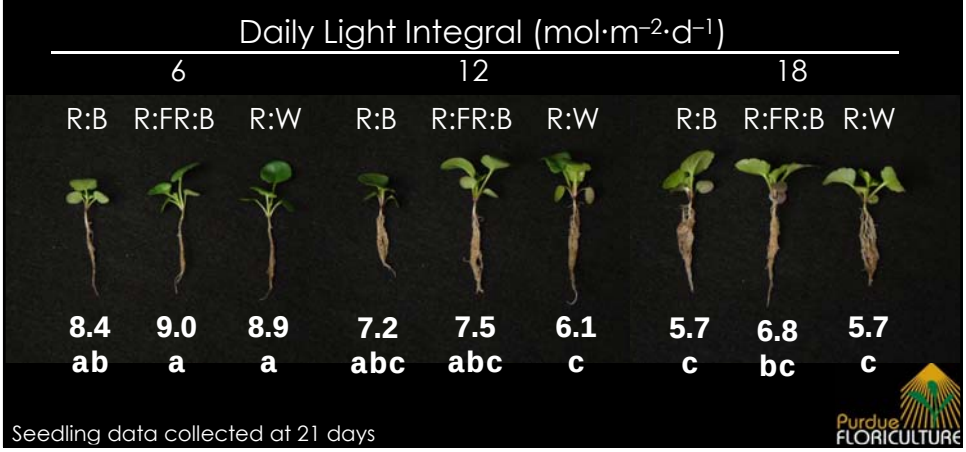
Materials and Methods

- Seedlings evaluated at 14, 21, and 28 days
  - Stem elongation
  - Stem caliper (SC)
  - Leaf area
  - Root, shoot and total dry mass (TDM)
  - Root to shoot ratio (R:S)
  - Sturdiness quotient (SQ; stem caliper / stem length)
  - Quality index [TDM (R:S +SQ)]

Preliminary Results

Pansy – Stem Elongation (mm)

- Increasing DLI led to decreased stem elongation



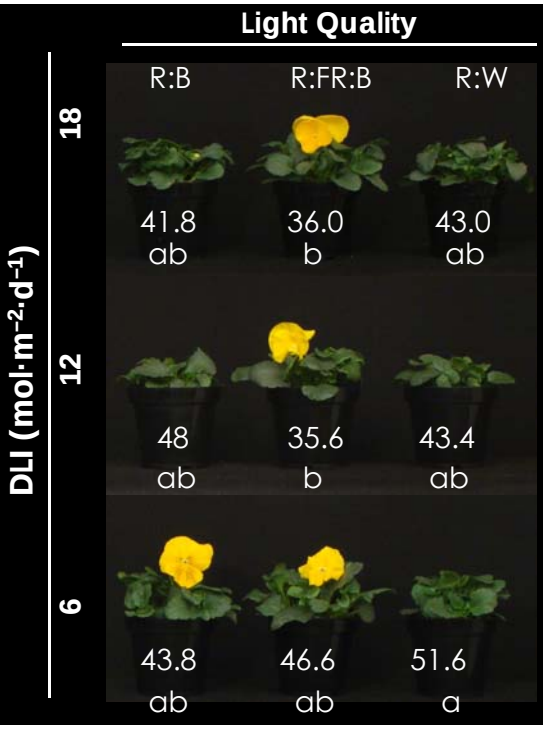
Seedling data collected at 21 days

Materials and Methods

- Five seedlings transplanted at 21 and 28 days
- Finishing environment
  - Photoperiod: 16-hr
  - DLI of 10-12 mol·m^{-2}·d^{-1}
  - Air temperature: 68 °F (20 °C)
  - Fertilized with 200 ppm N

Pansy – Time to Flower

- R:FR:B flowered ~ 6 days earlier for High DLI
- R:FR:B flowered ~ 8 days earlier for Medium DLI



Preliminary Conclusions

- Higher quality plugs under higher DLIs
  - Decreased stem elongation
  - Increased stem caliper
  - Increased root and shoot dry mass
- Light quality does not appear to have a significant effect within DLIs on plug quality
- Earlier flowering for some species under R:FR:B LEDs with higher DLIs
- Results are still preliminary

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