OptimIA

MICHIGAN STATE UNIVERSITY

UV and blue light

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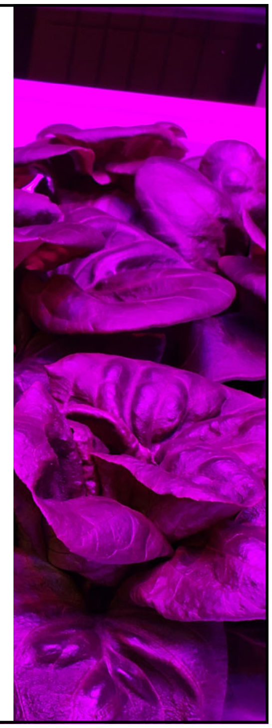

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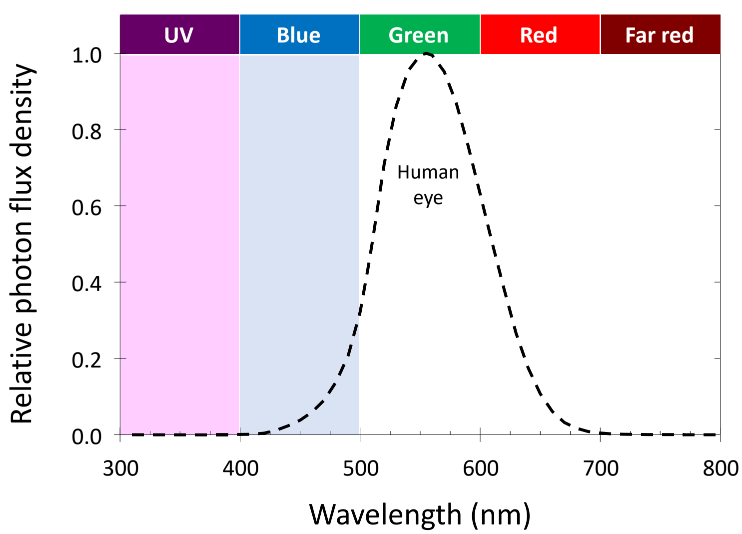
Light Wavebands for Plants and People



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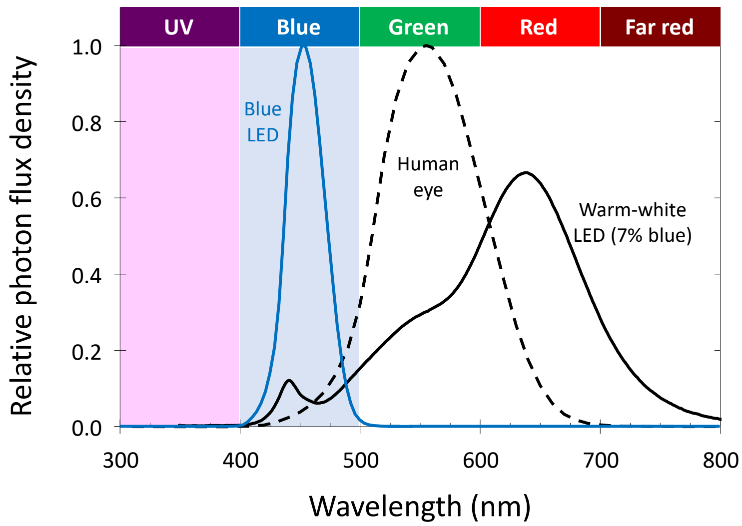
Light Wavebands for Plants and People



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UV and Blue Light Wavebands

- Blue: 400 to 500 nm
- UV-A: 315 to 400 nm
- UV-B: 280 to 315 nm
- UV-C: 100 to 280 nm
- The energy of radiation increases as the wavelength decreases
- These high-energy wavebands can cause eye and skin damage and use necessitates proper safety precautions, especially eye protection

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UV and Blue Light Wavebands

- Typically suppress extension growth
- Can regulate synthesis of secondary metabolites that influence leaf color and taste including:
  - ✓ Phenolics: A group of compounds that have antioxidant capacities and impart various flavors and colors
  - ✓ Anthocyanins: A phenolic compound that influences leaf coloration

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UV and Blue Light Wavebands

- Compared with blue LEDs, UV LEDs are substantially more expensive, less efficacious, and have shorter lifetimes
- UV-B and UV-C can suppress/kill pathogens and other microorganisms, and decontaminate water and growing surfaces
- The “dose” (wavelength, flux density, and duration) of UV is important: sufficient to kill pathogen(s) but not inhibit growth or damage leaves

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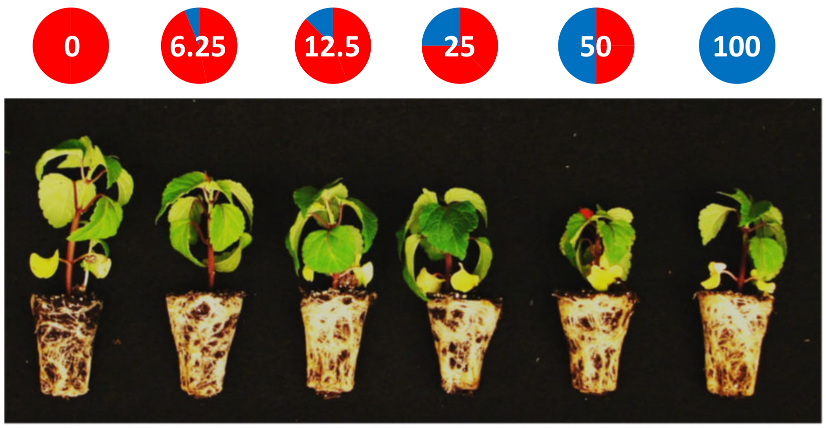
Salvia 'Vista Red'

Seedlings grown indoors at 68 °F (20 °C) for 4 weeks under LEDs with an 18-hour photoperiod at a PPFD= 160 μmol·m^{-2}·s^{-1} consisting of (%):

Percentage of blue light:



Wollaeger, H.M. and E.S. Runkle. 2015. HortScience 50:522-529.

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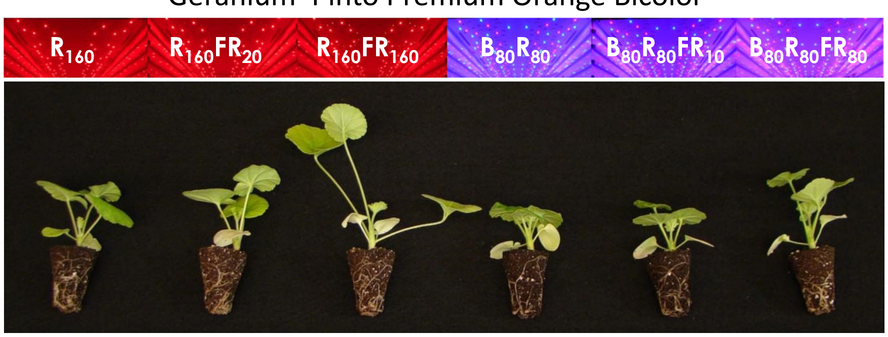
Effects of Blue Light on Seedling Growth

Seedlings grown at 68 °F (20 °C) for 24 days under LEDs (31 days after sow) with an 18-hour photoperiod

Geranium 'Pinto Premium Orange Bicolor'



4.5 c	6.0 b	9.2 a	3.6 d	4.4 c	5.8 b

Plant height (cm)

Park, Y. and E.S. Runkle. 2019. Environ. Exp. Bot. 168 (article 103871).

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Effects of Blue Light on Seedling Growth

Seedlings grown at 68 °F (20 °C) for 25 days under LEDs
(32 days after sow) with an 18-hour photoperiod

Coleus 'Golden Wizzard'

4.8 b	5.2 b	7.8 a	1.6 c	1.7 c	1.7 c

Plant height (cm)

Park, Y. and E.S. Runkle. 2019. Environ. Exp. Bot. 168 (article 103871).

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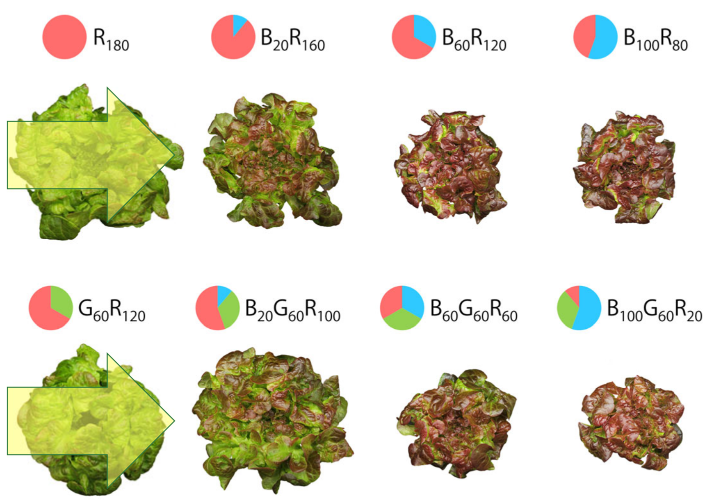
Red-leaf Lettuce 'Rouxai'

TPFD =180 µmol·m^{-2}·s^{-1} with a 20-hour photoperiod at 72 °F (22 °C)



Meng, Q., J. Boldt, and E.S. Runkle. 2020. J. Amer. Soc. Hort. Sci. 145:75-87.

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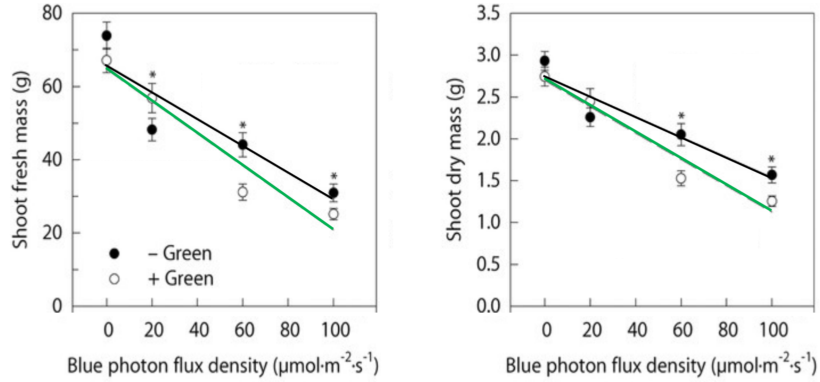
Red-leaf Lettuce 'Rouxai'



Meng, Q., J. Boldt, and E.S. Runkle. 2020. J. Amer. Soc. Hort. Sci. 145:75-87.

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Phasic Lighting

<u>Objective</u>

- To understand how changing light quality during the production of leafy greens influences plant quality and yield

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Materials and Methods

- Red-leaf 'Rouxai' lettuce
- Photoperiod of 20 hours/day and air temperature of 73 °F (23 °C)
- TPFD of 180 µmol·m^{-2}·s^{-1} from blue, red, green, far-red and/or warm-white LEDs: WW_{180}, R_{180}, $B_{20}R_{160}$, $B_{20}G_{60}R_{100}$, $B_{20}R_{100}FR_{60}$, and B_{180}
- Seedlings were transferred from each of the 6 treatments on day 11 to the other treatments, for a total of 36 lighting treatments
- Plants were harvested on day 25

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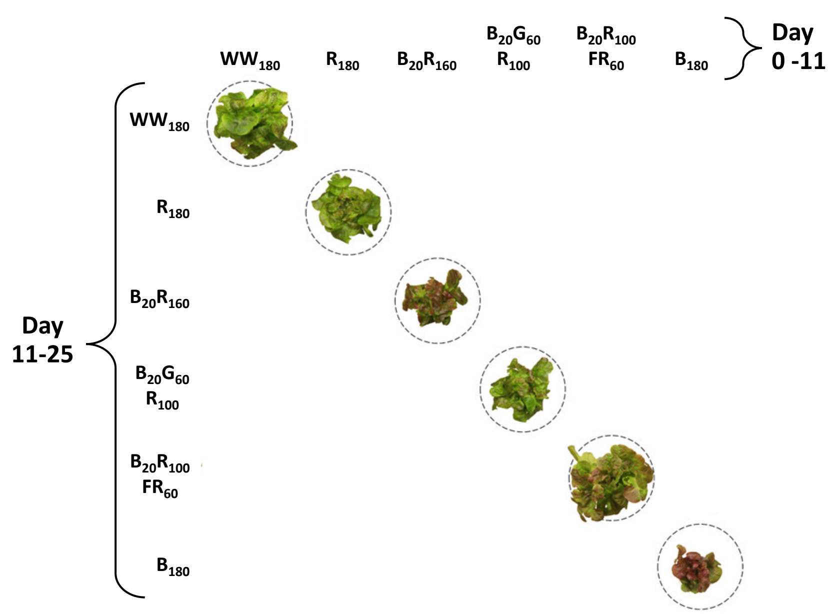
Results



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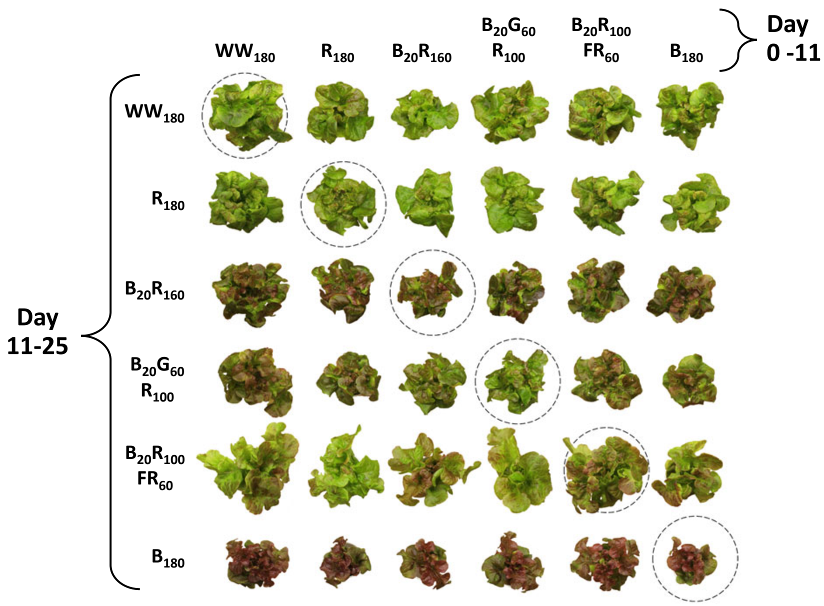
Results



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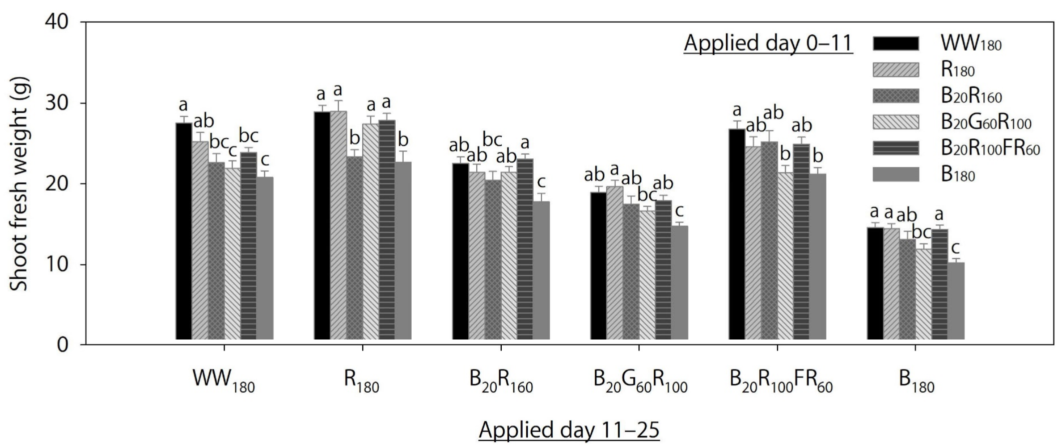
Results



Meng, Q. and E.S. Runkle. 2020. Front. Plant Sci. 11:571788.

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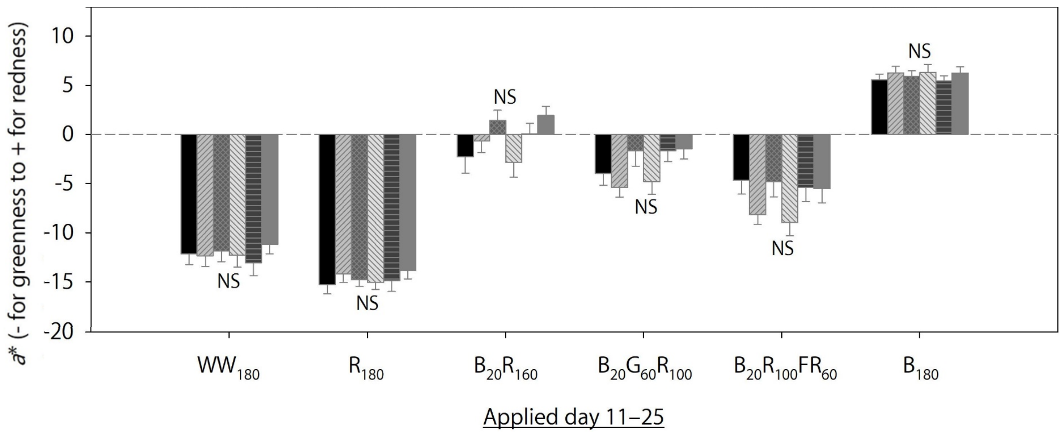
Results



Meng, Q. and E.S. Runkle. 2020. Front. Plant Sci. 11:571788.

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End-of-Production Lighting

Objectives

- Confirm that end-of-production lighting can increase quality of leafy greens grown indoors without decreasing yield
- Compare the efficacy of UV-A relative to B light at influencing leaf color and production of secondary metabolites

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Materials and Methods

- Red-leaf 'Rouxai' lettuce
- Photoperiod of 20 hours/day and air temperature of 73 °F (23 °C)
- TPFD of 180 µmol·m^{-2}·s^{-1} from 55% red (peak=665 nm) and 45% warm white LEDs
- Six days of end-of-production lighting from UV-A (peak= 385 nm) and/or blue (peak=449 nm) LEDs, with two controls (no additional lighting, or with red and green light)

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Preliminary Results

Lettuce 'Rouxai' grown under 180 µmol·m^{-2}·s^{-1} for 20 hours/day at 73 °F (23 °C) for 24 days, then for 6 days with additional light:

None	UV-A_{30}	B_{30}	UV-A_{30}+B_{30}	B_{60}	G_{20}+R_{40}

–24 b	–15 ab	–13 ab	–8 a	–7 a	–22 b

CIELAB color space *a* value (more positive means more red)

Ultraviolet–A (UV-A; peak=385 nm), blue (B; peak=449 nm), green (G; peak=532 nm), red (R; peak=664 nm)

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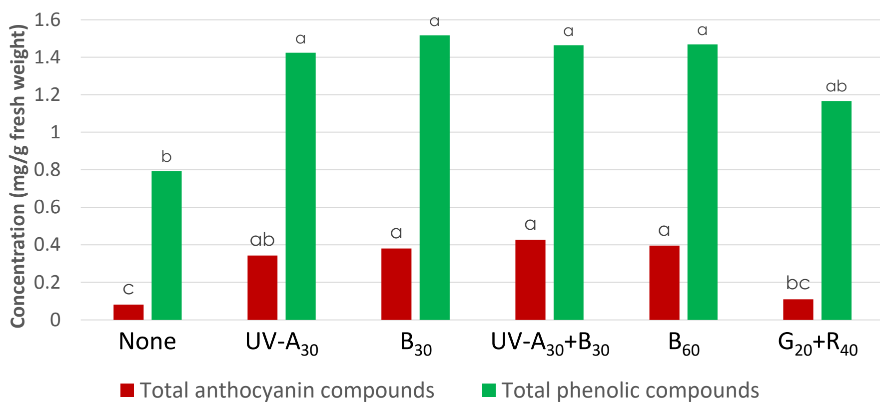
Preliminary Results

Lettuce 'Rouxai' grown under 180 µmol·m^{-2}·s^{-1} for 20 hours/day at 73 °F (23 °C) for 24 days, then for 6 days with additional light:



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Phasing Lighting with UV-A and Blue Light

Objective

- To determine how the timing of UV-A or blue light during the production of lettuce influences growth, quality, and nutritional attributes

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Materials and Methods

- Red-leaf lettuce 'Rouxai'
- Air temperature of 73 °F (23 °C)
- Photoperiod of 20 hours/day
- Lighting at a TPFD of 150 µmol·m^{-2}·s^{-1}, half from red (peak = 664 nm) and half from warm-white LEDs
- UV-A, blue, or red +green (peak = 532 nm) light was added during:
  - seedling phase (day 4-12),
  - growth phase (day 12-20), and/or
  - finishing phase (day 20-28)

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Preliminary Results

Lettuce 'Rouxai' grown under 150 µmol·m^{-2}·s^{-1} for 20 hours/day at 73 °F (23 °C) for 28 days with supplemental lighting of:

None (control) | **$G_{10}R_{20}$** | **UV-A_{30}** | **B_{30}**

Ultraviolet–A (UV-A; peak=385 nm), blue (B; peak=449 nm), green (G; peak=532 nm), red (R; peak=664 nm)

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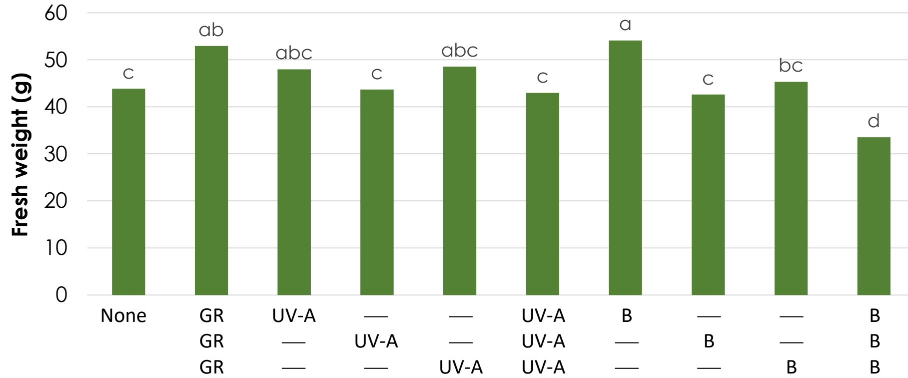
Preliminary Results

Lettuce 'Rouxai' grown under 150 µmol·m^{-2}·s^{-1} for 20 hours/day at 73 °F (23 °C) for 28 days with supplemental lighting of:



Lighting period 1: day 4-12; period 2: day 12-20; period 3: day 20-28

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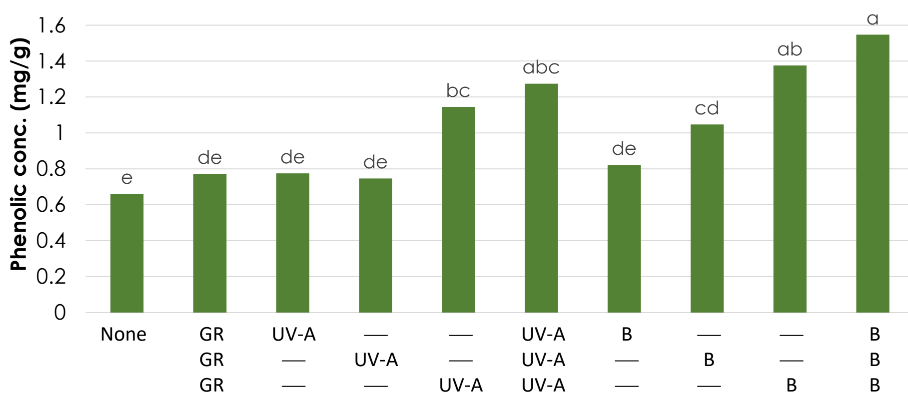
Preliminary Results

Lettuce 'Rouxai' grown under 150 µmol·m^{-2}·s^{-1} for 20 hours/day at 73 °F (23 °C) for 28 days with supplemental lighting of:



Lighting period 1: day 4-12; period 2: day 12-20; period 3: day 20-28

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Summary and Conclusions

- Blue light and UV-A radiation typically inhibit extension growth and increase quality, but can suppress biomass accumulation
- UV-A and UV-B can increase leaf coloration, although blue light was equality effective as UV-A radiation
- UV-B and especially UV-C can kill microorganisms, but strict precautions are needed to protect employees
- Enriching the spectrum with blue light near the end of production could be a useful approach to increase quality without suppressing yield

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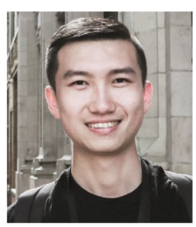
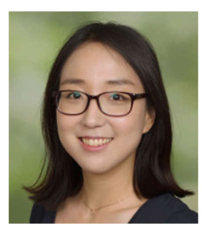
Acknowledgments

Nathan Kelly



Qingwu Meng



Yujin Park

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