

# Effects of White LEDs on Growth and Phytonutrients of 'Outredgeous' Romaine Lettuce When Supplemented with Various Monochromatic Wavelengths

Matthew Mickens, Emilie J. Skoog, Payton Barnwell, Gioia Massa, and Raymond Wheeler

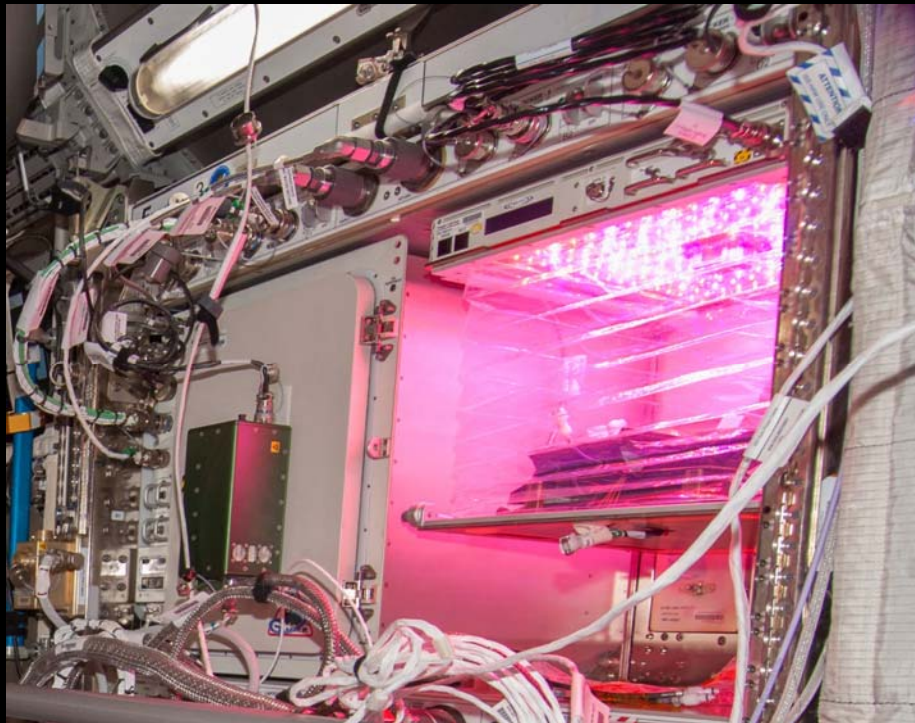
Kennedy Space Center

NASA Postdoctoral Program (NPP)

Exploration Research and Technology Programs

# Is the “Pink Glow” Optimal?

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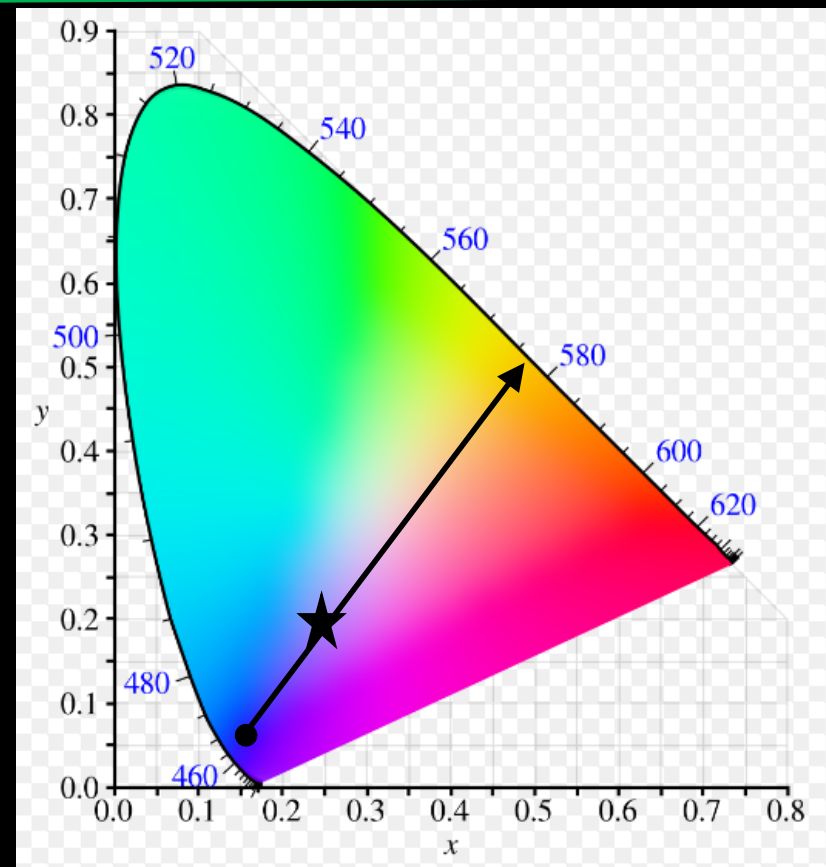
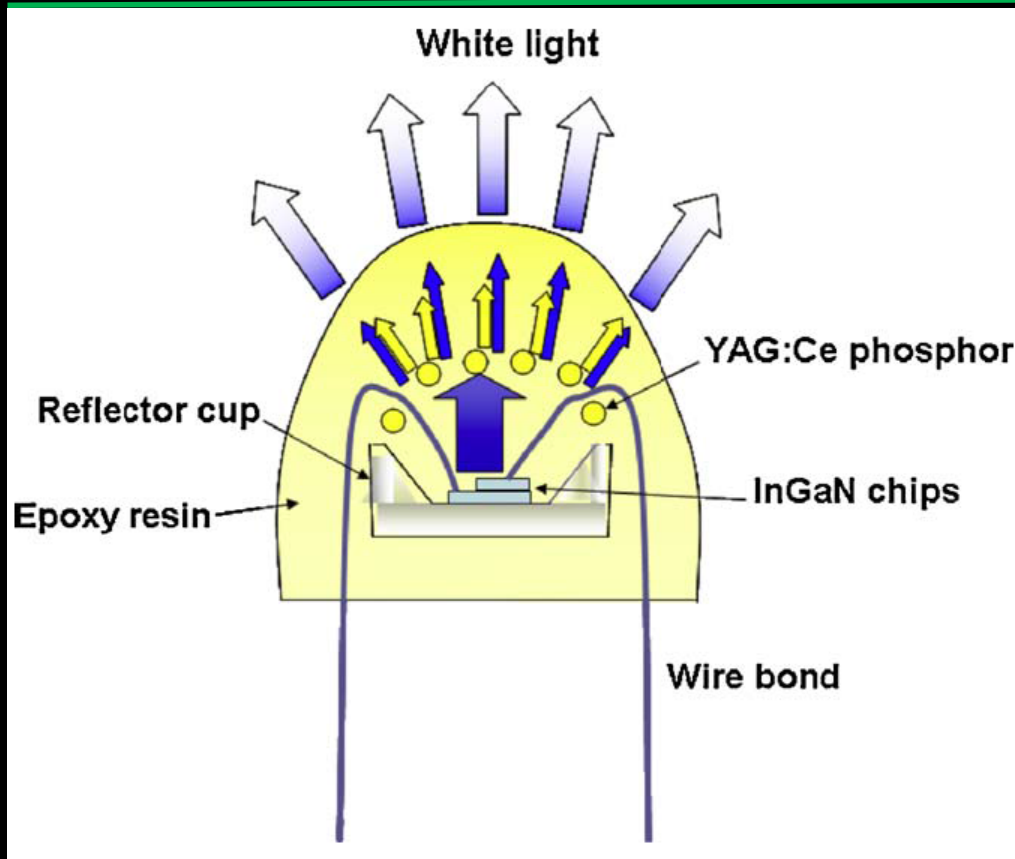
**ISS VEGGIE Chamber  
Flight Experiments**



**Kennedy Space Center  
Ground Experiments**



# Using WLEDs for Plant Growth

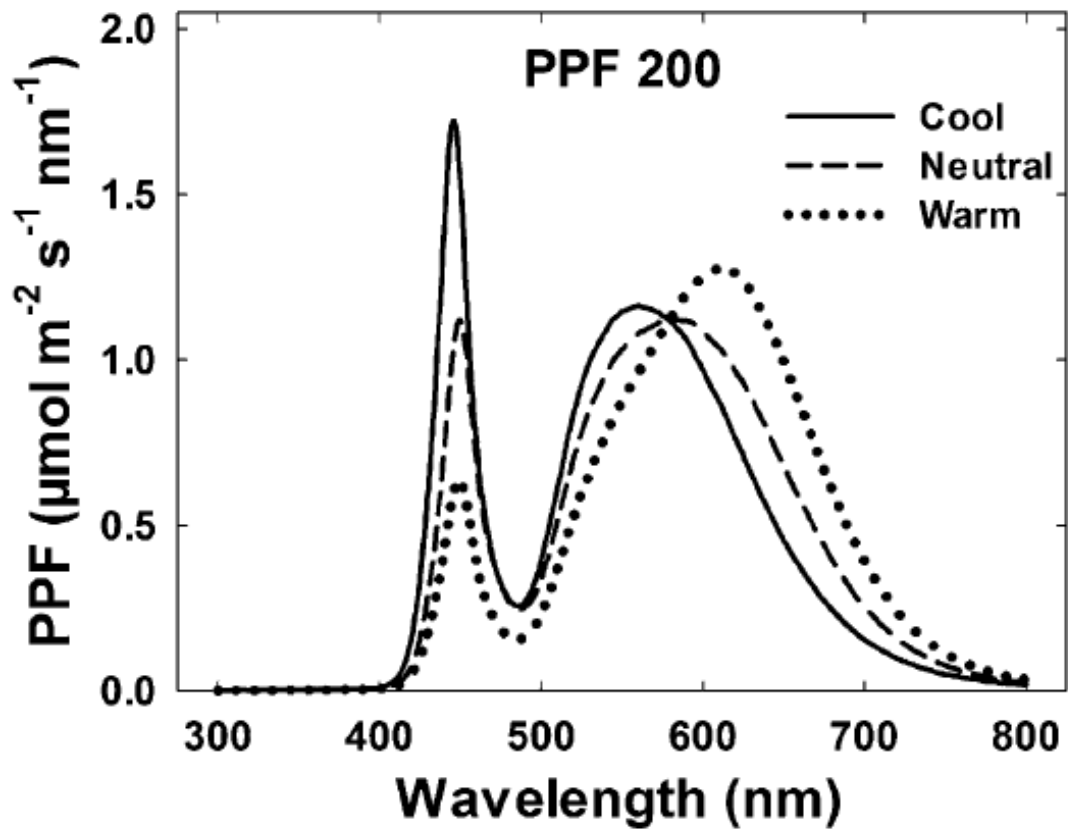


Phosphors in phosphor-converted white light-emitting diodes: Recent advances in materials, techniques and properties. S. Ye, F. Xiao, Y.X. Pan, Y.Y. Ma, Q.Y. Zhang. Mater. Sci. Eng. R 71 (2010) 1-34.

CIE Chromaticity Diagram



# WLED Spectra



## Spectral Effects of Three Types of White Light-emitting Diodes on Plant Growth and Development: Absolute versus Relative Amounts of Blue Light

Kevin R. Cope<sup>1</sup> and Bruce Bugbee

*Department of Plants Soils and Climate, Utah State University,  
4820 Old Main Hill, Logan, UT 84322-4820*



# Objectives:

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- 1. By using WLEDs as a background, sought to examine the effects of enriched B, G, R, and FR regions of the spectrum on growth of lettuce (SLLED).**
- 2. To identify strategic “light recipes” that could be used for ‘Outredgeous’ lettuce grown in the Advanced Plant Habitat (APH) and future growth chamber environments.**
- 3. To determine the effects of the light treatments on nutrient content secondary metabolites.**



# WLED Fixture

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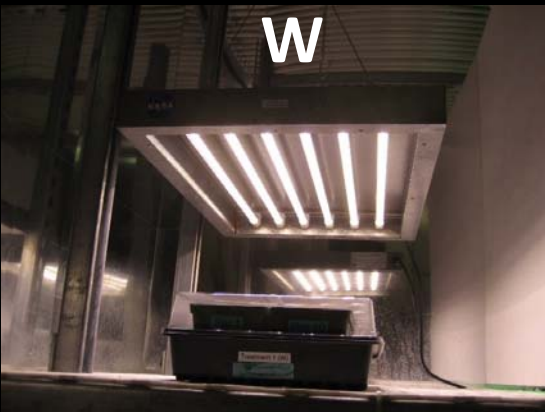


AIBC Full Spectrum Super T Panel (Ithaca, NY)



Treatment 1 (Control)

W



Total PPF: ~180

B = 20%, G = 47%, R = 31%

Treatment 2

RB



Total PPF: ~180

B = 40%, G = 0%, R = 60%

Treatment 3

W+B

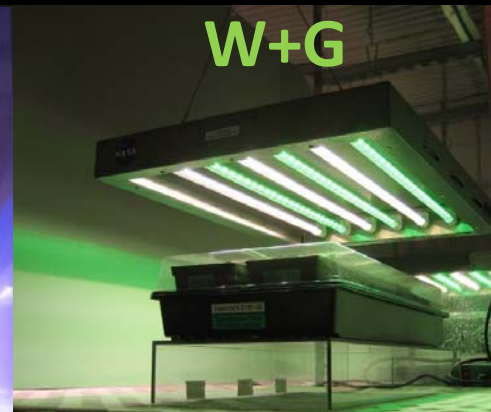


Total PPF: ~180

B = 43%, G = 34%, R = 23%

Treatment 4

W+G

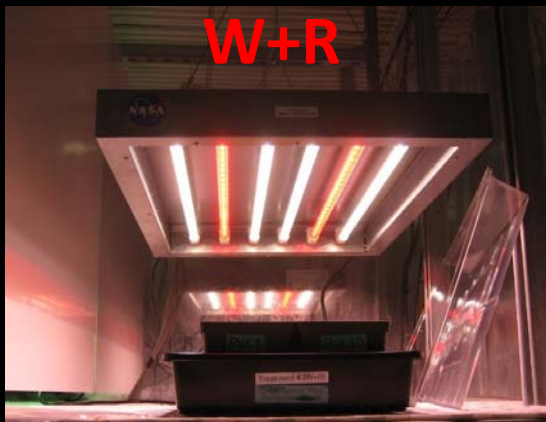


Total PPF: ~180

B = 17%, G = 57%, R = 24%

Treatment 5

W+R

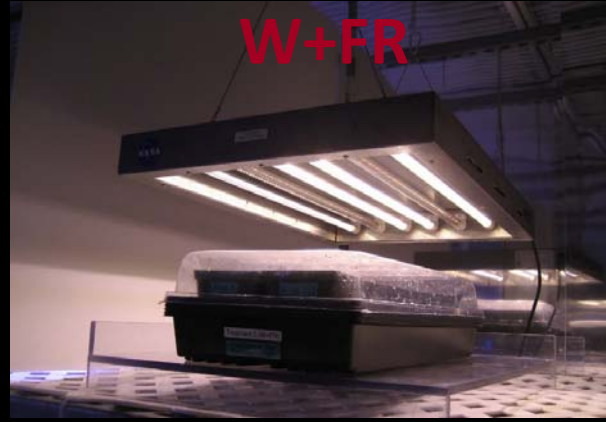


Total PPF: ~180

B = 16%, G = 38%, R = 46%

Treatment 6

W+FR



Total PPF: ~180

B=16%, G=39%, R=25%, FR=30  $\mu\text{mol}/\text{m}^2/\text{sec}$

Treatment 7

RGB+FR



Total PPF: ~180

B=15%, G=25%, R=60%, FR=30  $\mu\text{mol}/\text{m}^2/\text{sec}$



7 DAP

Treatment 1



White (Control)

Treatment 2



RB

Treatment 3



White + Blue (460 nm)

Treatment 4



White + Green (525 nm)

Treatment 5



White + Red (635 nm)

Treatment 6



White + Far Red (745 nm)

Treatment 7



RGB + FR



# 14 DAP

Treatment 1



White (Control)

Treatment 2



RB

Treatment 3



White + Blue (460 nm)

Treatment 4



White + Green (525 nm)

Treatment 5



White + Red (635 nm)

Treatment 6



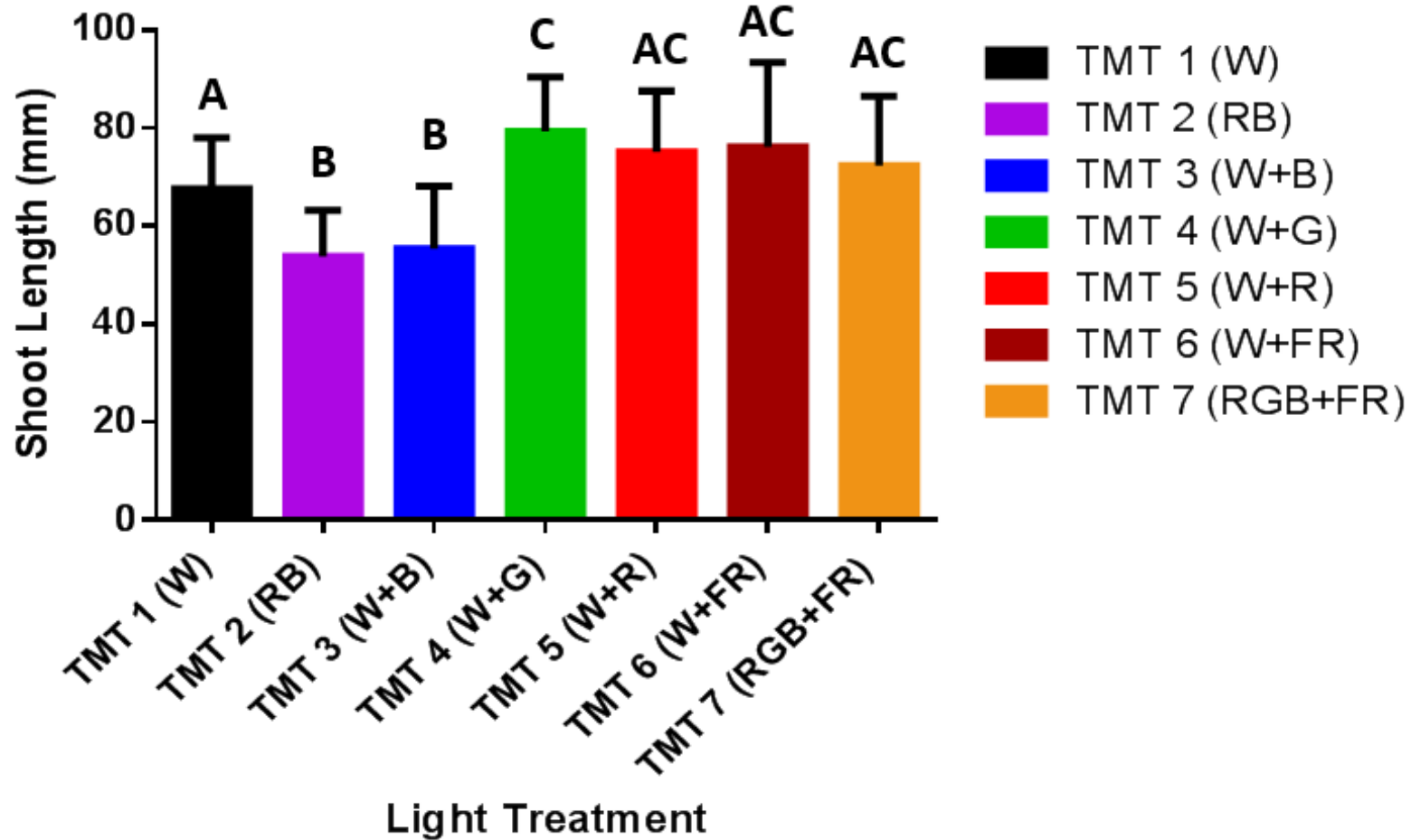
White + Far Red (745 nm)

Treatment 7

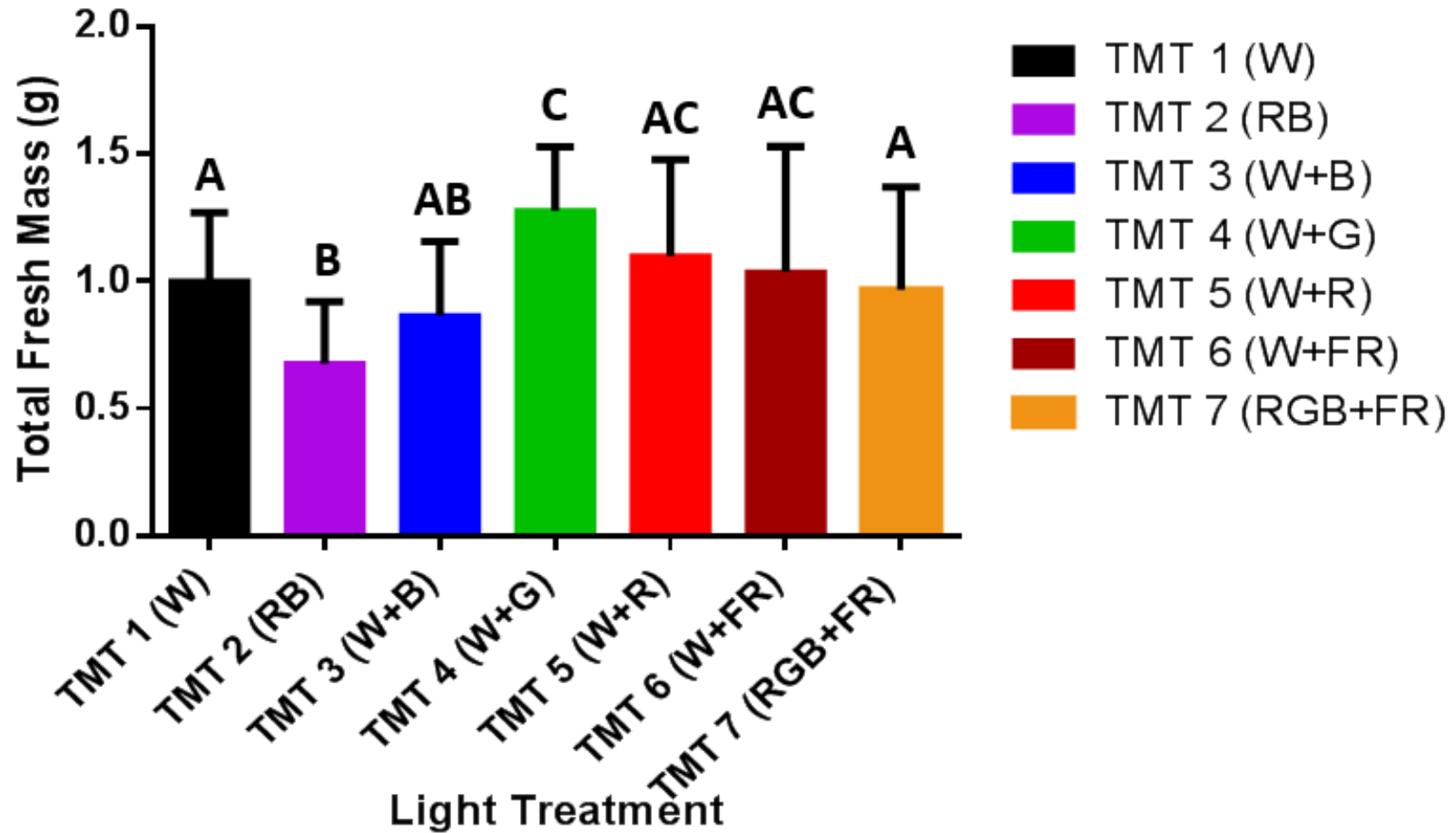


RGB + FR

## Shoot Length (14 DAP)



## Total Fresh Mass (14 DAP)



# 21 DAP

Treatment 1



White (Control)

Treatment 2



RB

Treatment 3



White + Blue (460 nm)

Treatment 4



White + Green (525 nm)

Treatment 5



White + Red (635 nm)

Treatment 6



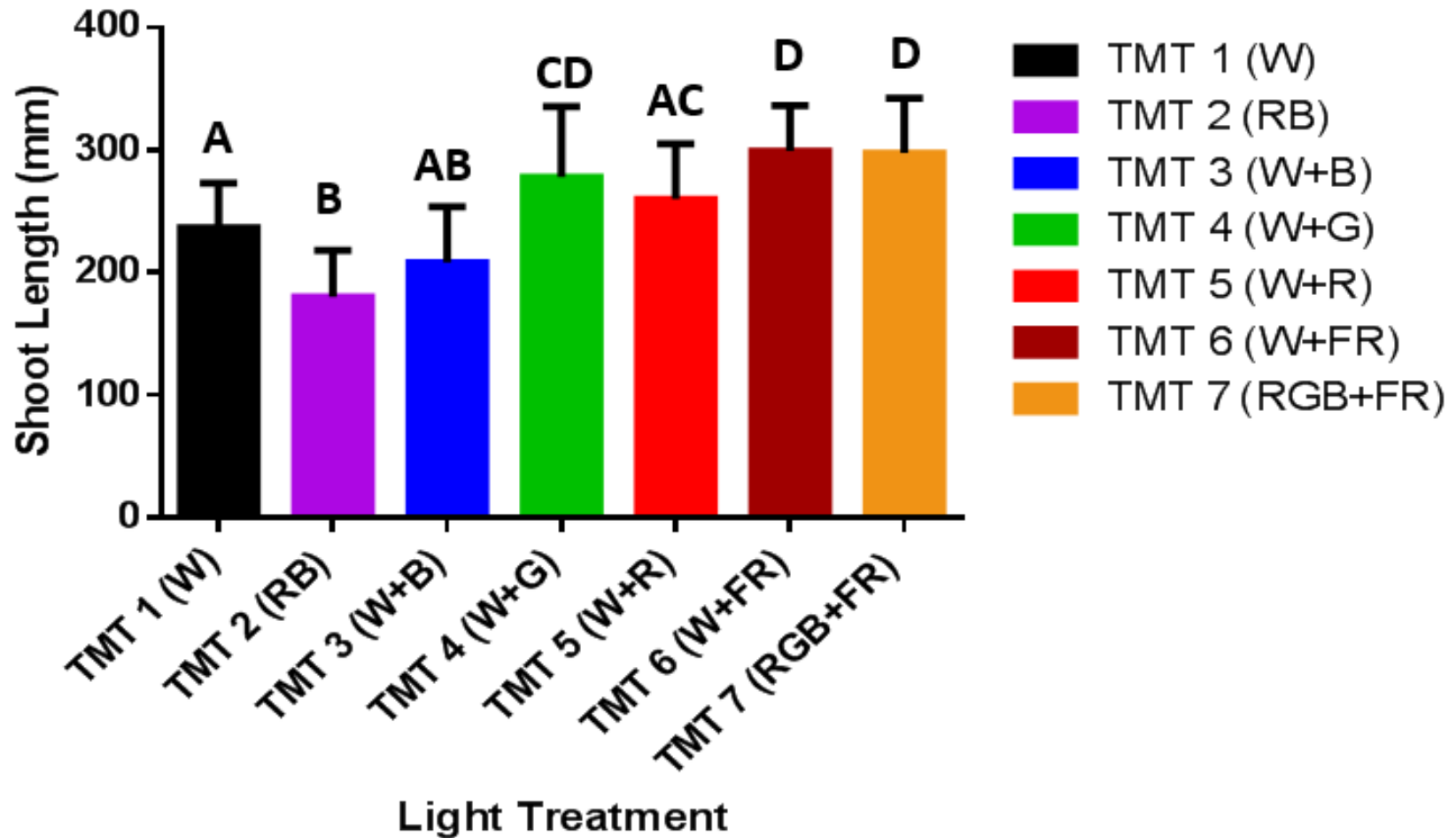
White + Far Red (745 nm)

Treatment 7



RGB + FR

## Shoot Diameter (21 DAP)



# 28 DAP

Treatment 1



White (Control)

Treatment 2



Red (635 nm) + Blue (460 nm)

Treatment 3



White + Blue (460 nm)

Treatment 4



White + Green (525 nm)

Treatment 5



White + Red (635 nm)

Treatment 6



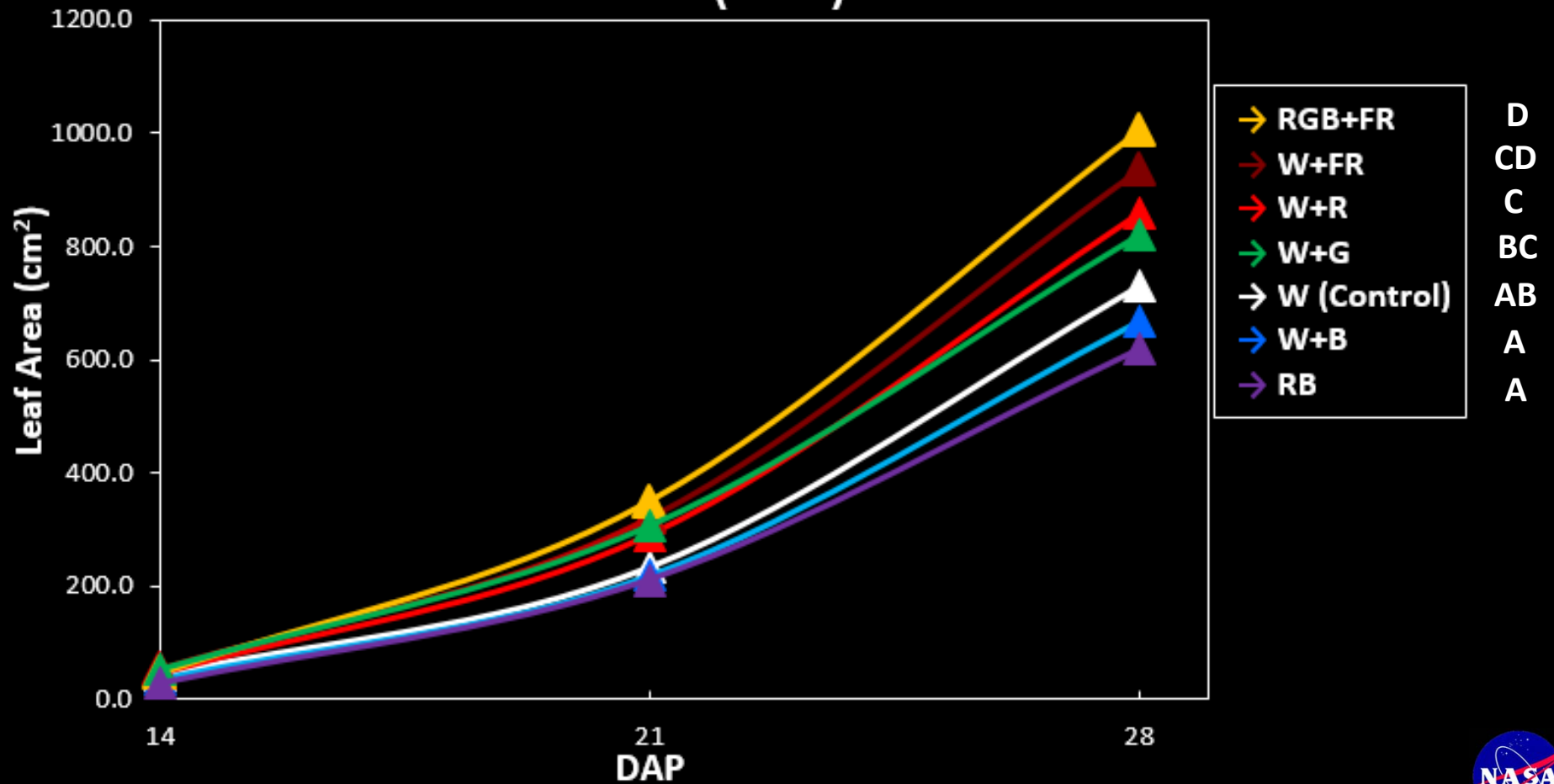
White + Far Red (745 nm)

Treatment 7



R (660 nm) + G (525 nm) + B (420 nm)  
+ FR (733 nm)

# Leaf Area (cm<sup>2</sup>)



# Elemental Nutrients



W



RB



W+B



W+G



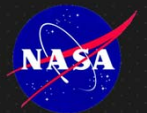
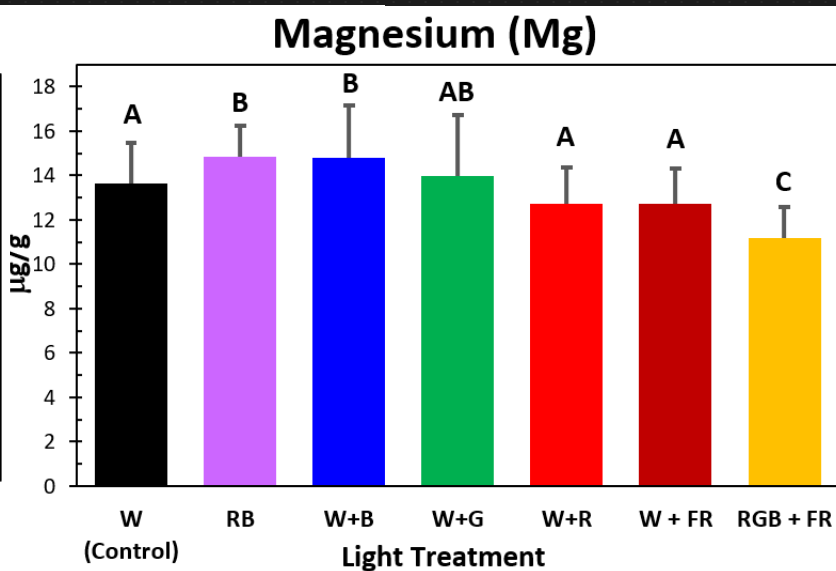
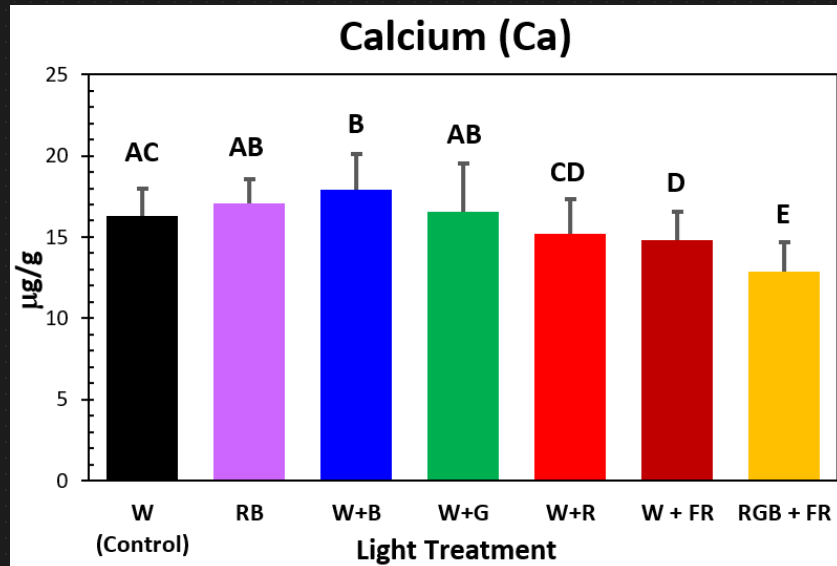
W+R



W+FR



RGB+FR







## Anthocyanin Content

**RB** = 8.7

**W+FR** = 4.5

**RGB+FR** = 7.0



# Conclusion

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**The effects of supplementing WLEDs with various monochromatic LEDs was dependent on plant age.**

**Overall, the WLED + Mono LEDs allowed for strategic altering of plant morphology.**

**WLEDs improved biomass compared to RB LEDs**

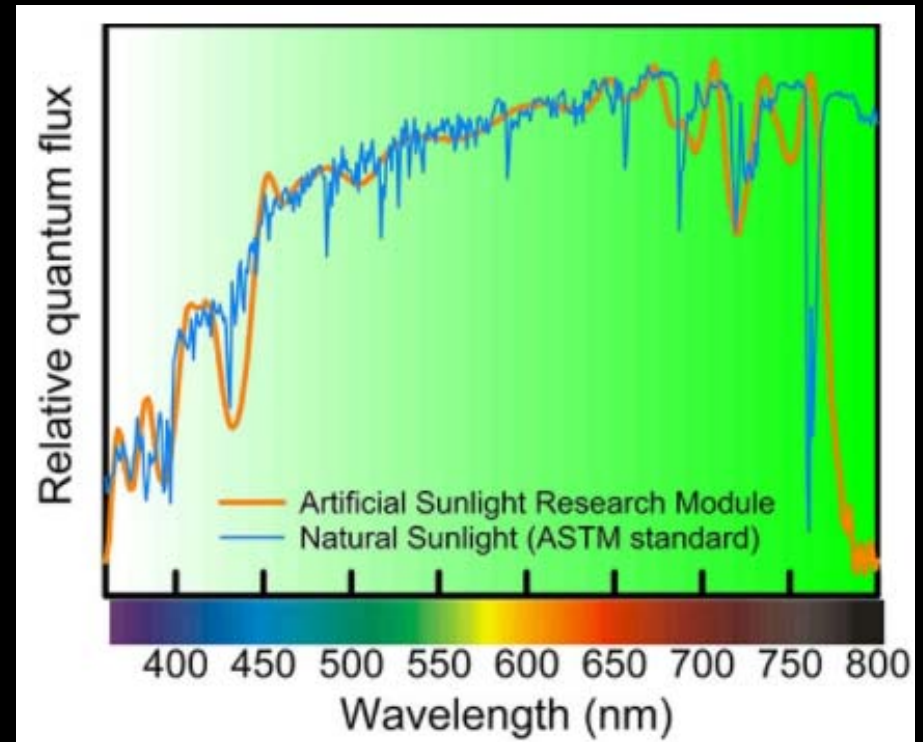
**Light ratios similar to sunlight could be even more beneficial than WLEDs.**

# Future in LED light Recipes



**Artificial Sunlight Research Module (ASRM)**

Source: Hogewoning SW, Douwstra P, Trouwborst G, van Ieperen W, Harbinson J. 2010. An artificial solar spectrum substantially alters plant development compared with usual climate room irradiance spectra. [Journal of Experimental Botany 61](#), 1267-1276



**Spectral Comparisons**



# My Team



Gioia Massa



Emilie Skoog



Payton Barnwell



Matt Romeyn



Ray Wheeler



Lashelle Spencer



Mary Hummerick

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was funded  
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GO

*Matthew A. Mickens, Ph.D.*  
*NASA Postdoctoral Research Scientist*  
*[matthew.a.mickens@nasa.gov](mailto:matthew.a.mickens@nasa.gov)*