

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

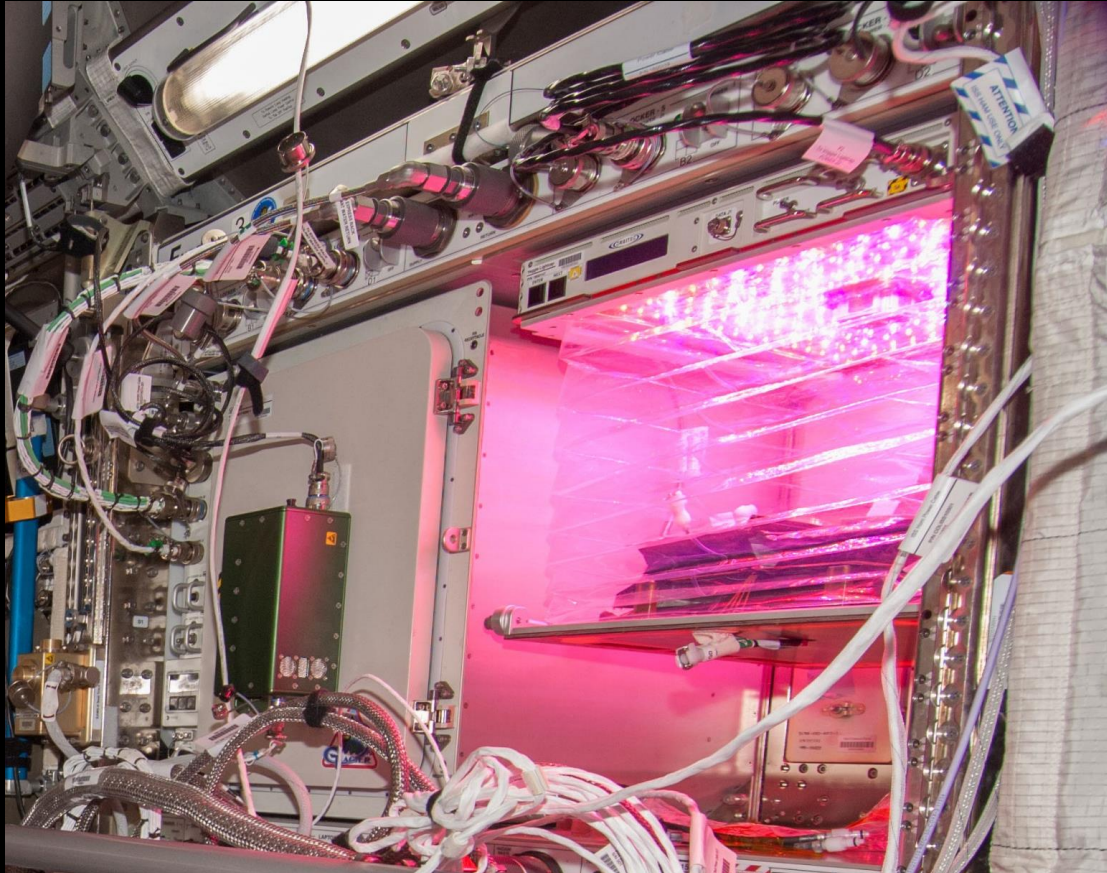
Matthew Mickens, Emilie J. Skoog, Payton Barnwell, Gioia Massa, and Raymond Wheeler

Kennedy Space Center

NASA Postdoctoral Program (NPP)

Exploration Research and Technology Programs

Is Red and Blue Light Optimal?

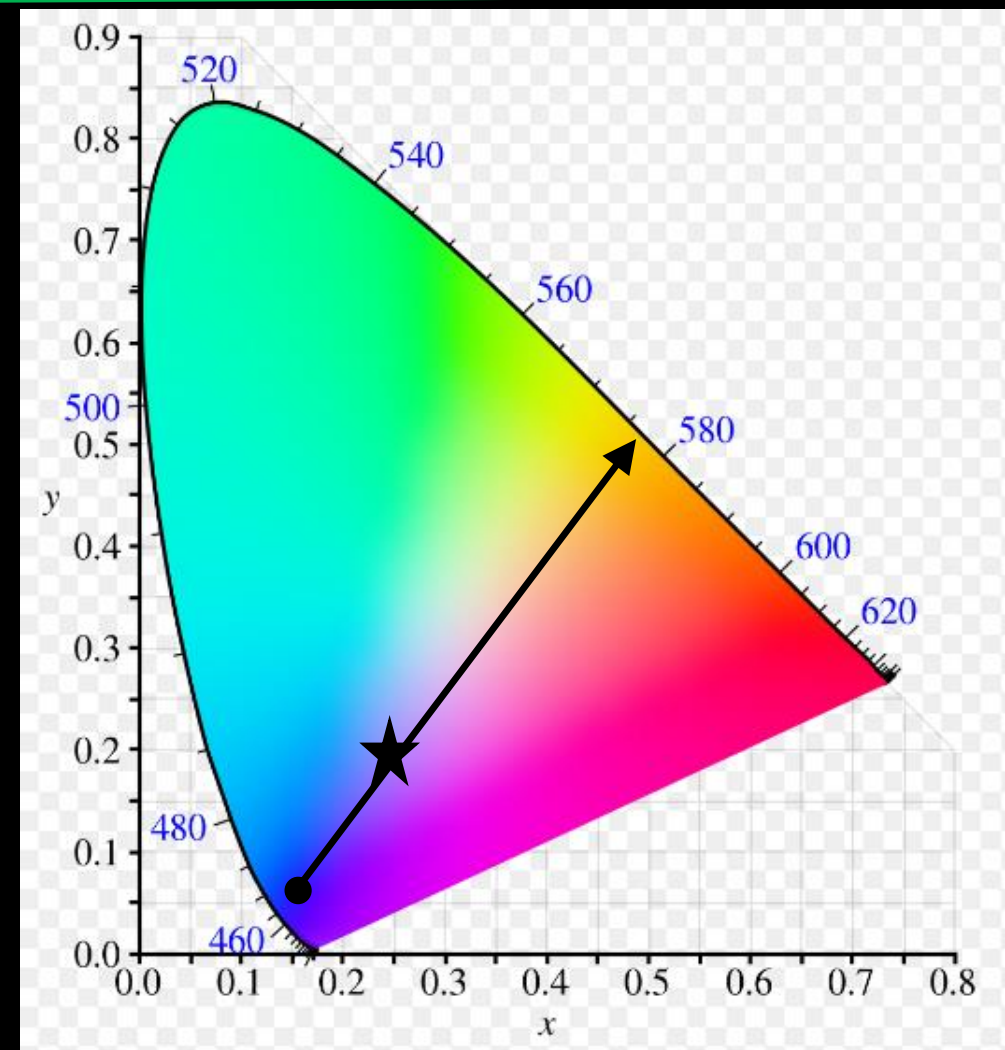
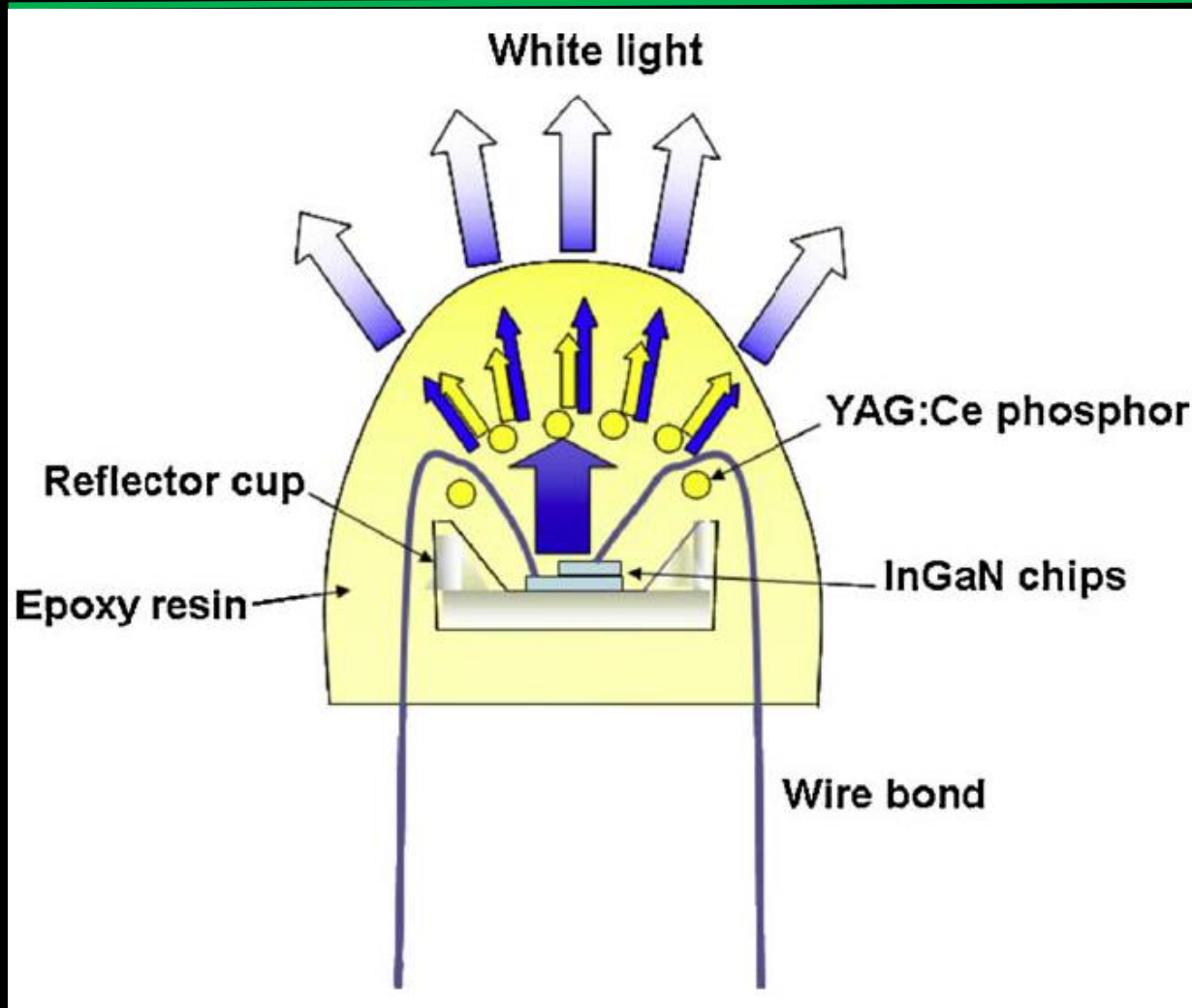


**ISS VEGGIE Chamber
Flight Experiments**



**Kennedy Space Center
Ground Experiments**

Using WLEDs for Plant Growth

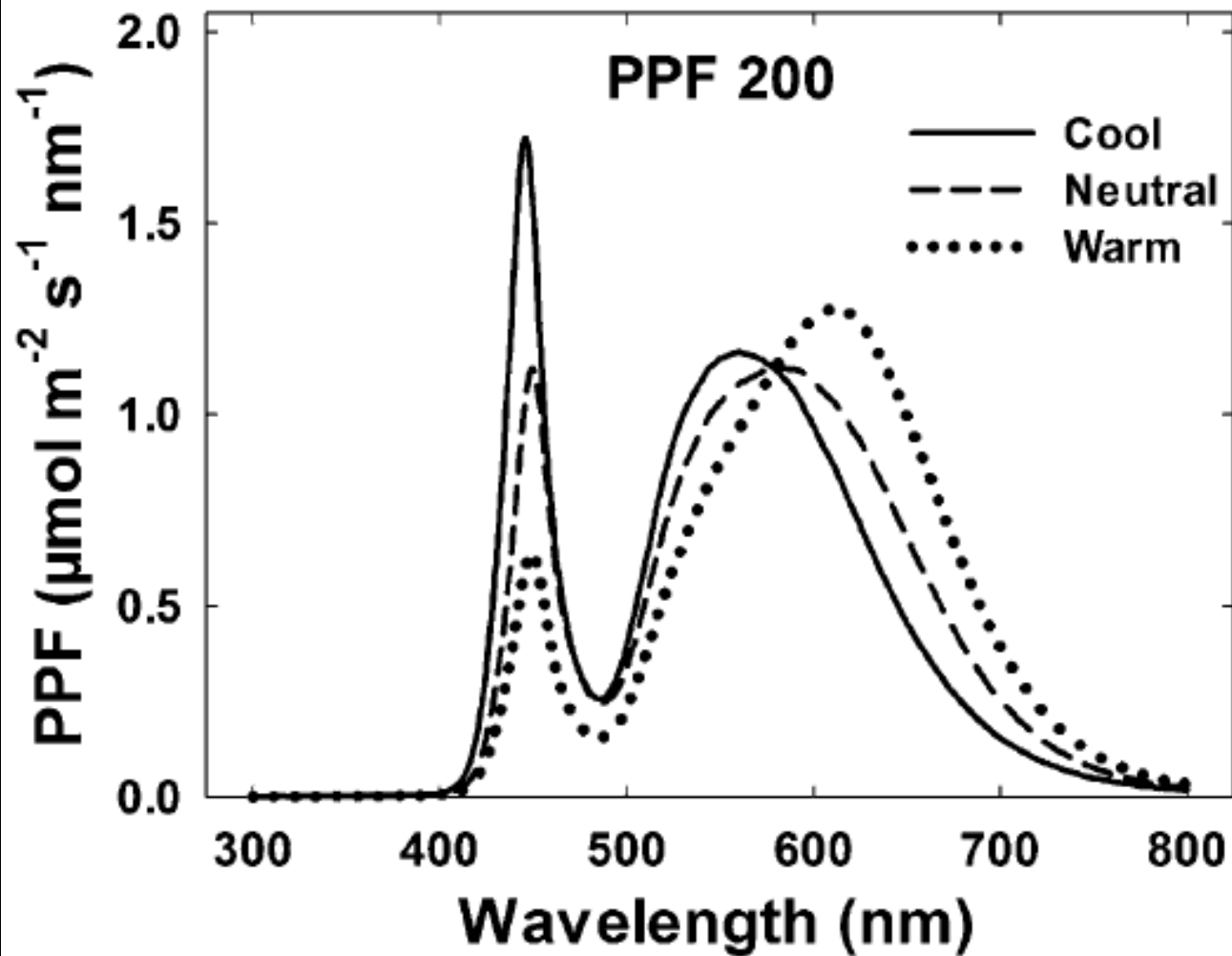


Phosphors in phosphor-converted white light-emitting diodes: Recent advances in materials, techniques and properties. S. Ye, F. Xiao, Y.X. Pan, Y.Y. Ma, Q.Y. Zhang. Mater. Sci. Eng. R 71 (2010) 1-34.

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

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Objectives:

- 1. To use LEDs to determine the effects of enriched B, G, R, and FR light on growth of lettuce when supplemented with WLEDs as a background.**
- 2. To identify optimal “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 secondary metabolites and nutrient content (ongoing).**



Cultural Conditions

- Arcillite clay media (< 1 mm particle size)
- Nutricote controlled-release fertilizer (NPK=18:6:8, Type 70 day)
- Air Temperature: 23 °C
- CO₂: 1200 μmol·mol⁻¹
- RH: 70 %
- Pots rotated 3 times a week
- Photoperiod: 18 hr light/6 hr dark



WLED Fixture

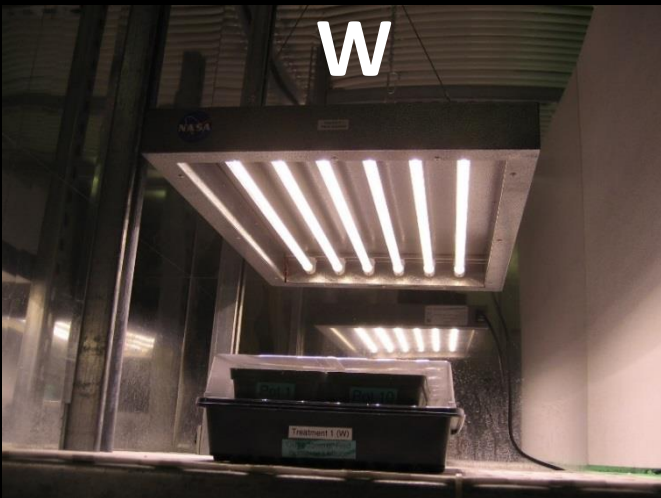


AIBC Full Spectrum Super T Panel (Ithaca, NY)



Treatment 1 (Control)

W



Total PPF: ~180

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

Treatment 2

RB

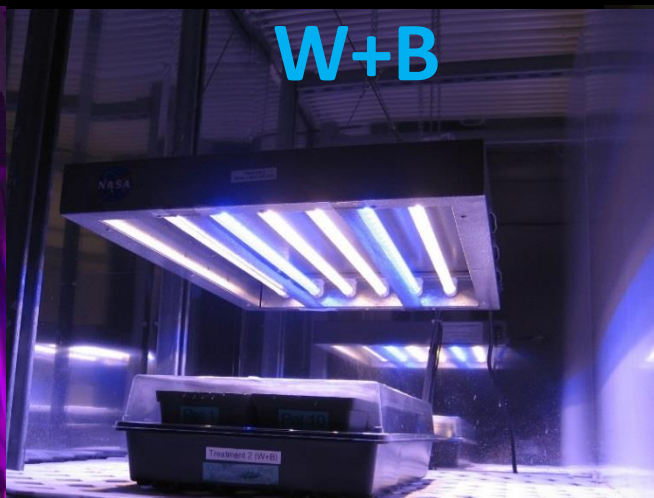


Total PPF: ~180

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

Treatment 3

W+B

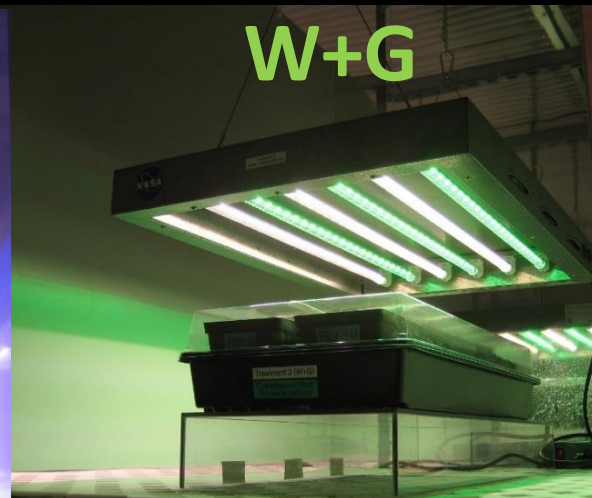


Total PPF: ~180

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

Treatment 4

W+G



Total PPF: ~180

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

Treatment 5

W+R

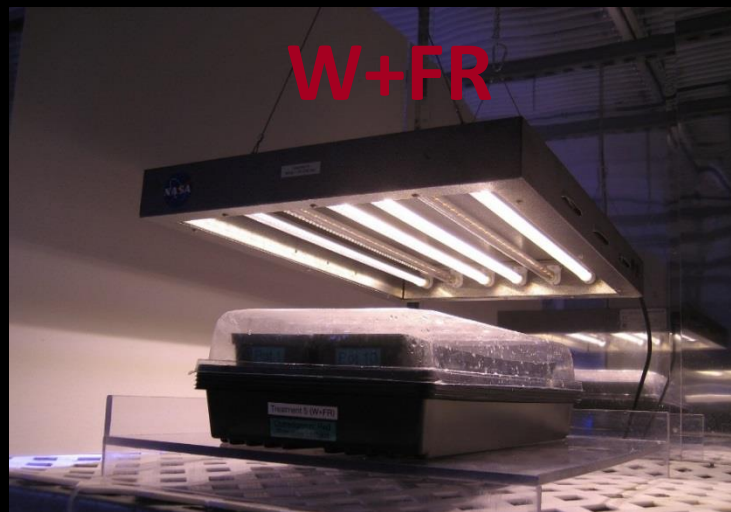


Total PPF: ~180

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

Treatment 6

W+FR



Total PPF: ~180

B=16%, G=39%, R=25%, FR=35 umol

Treatment 7

RGB+FR



Total PPF: ~180

B=15%, G=25%, R=60%, FR=35 umol

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



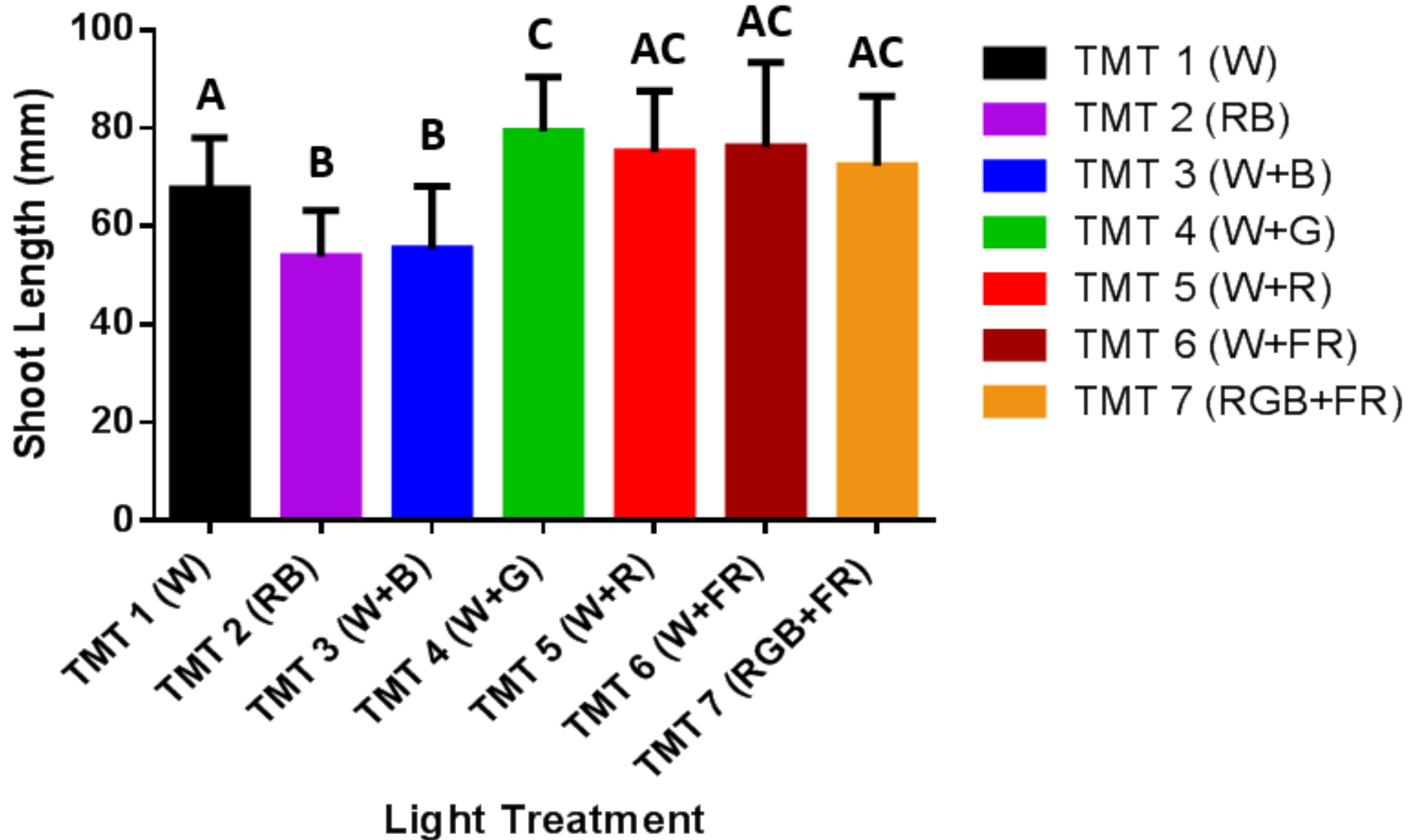
White + Far Red (745 nm)

Treatment 7

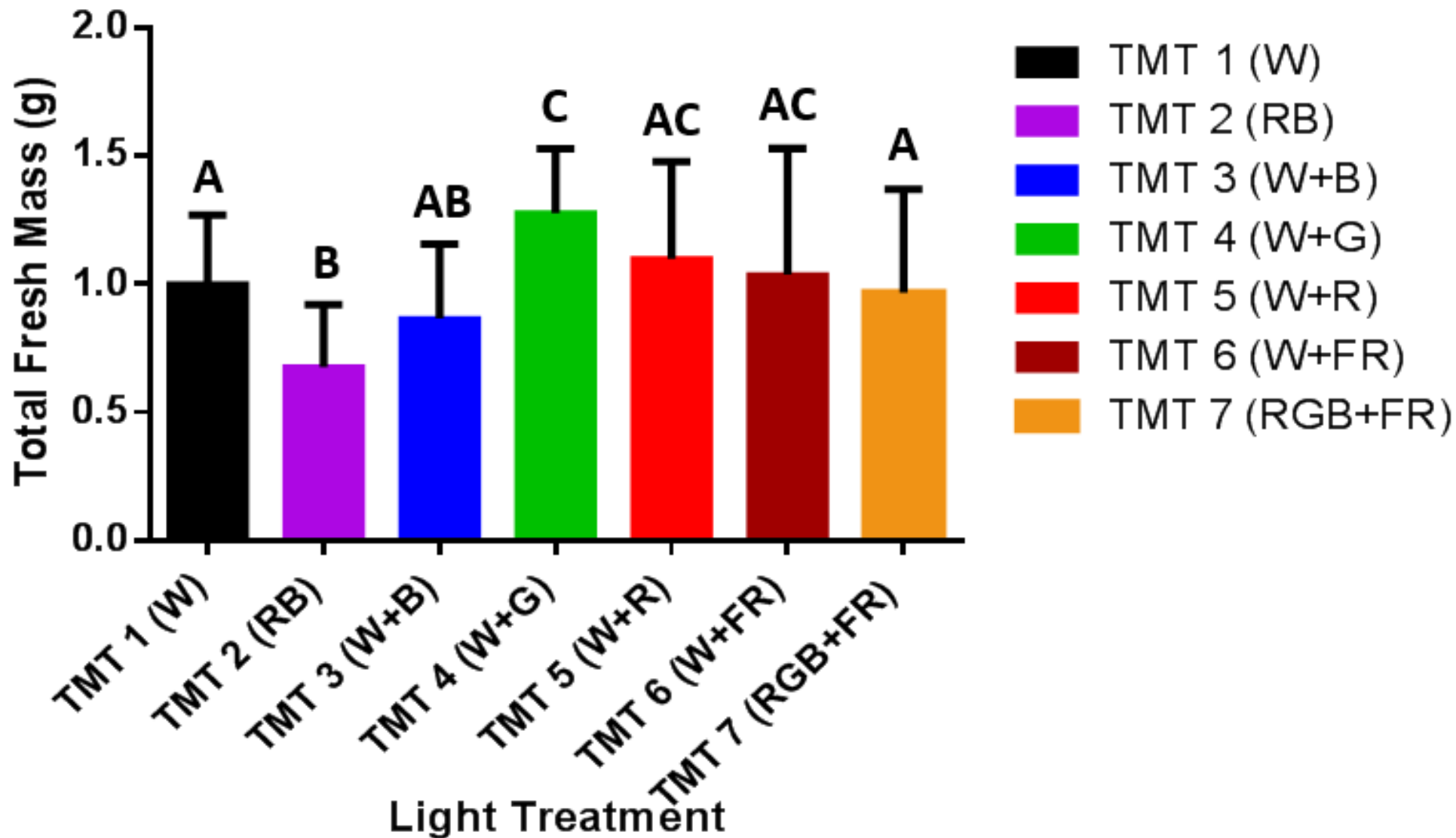


RGB + FR

Shoot Length (14 DAP)



Total Fresh Mass (14 DAP)



21 DAP

Treatment 1



White (Control)

Treatment 2



White + Blue (460 nm)

Treatment 3



White + Green (525 nm)

Treatment 4



Treatment 5



White + Red (635 nm)

Treatment 6



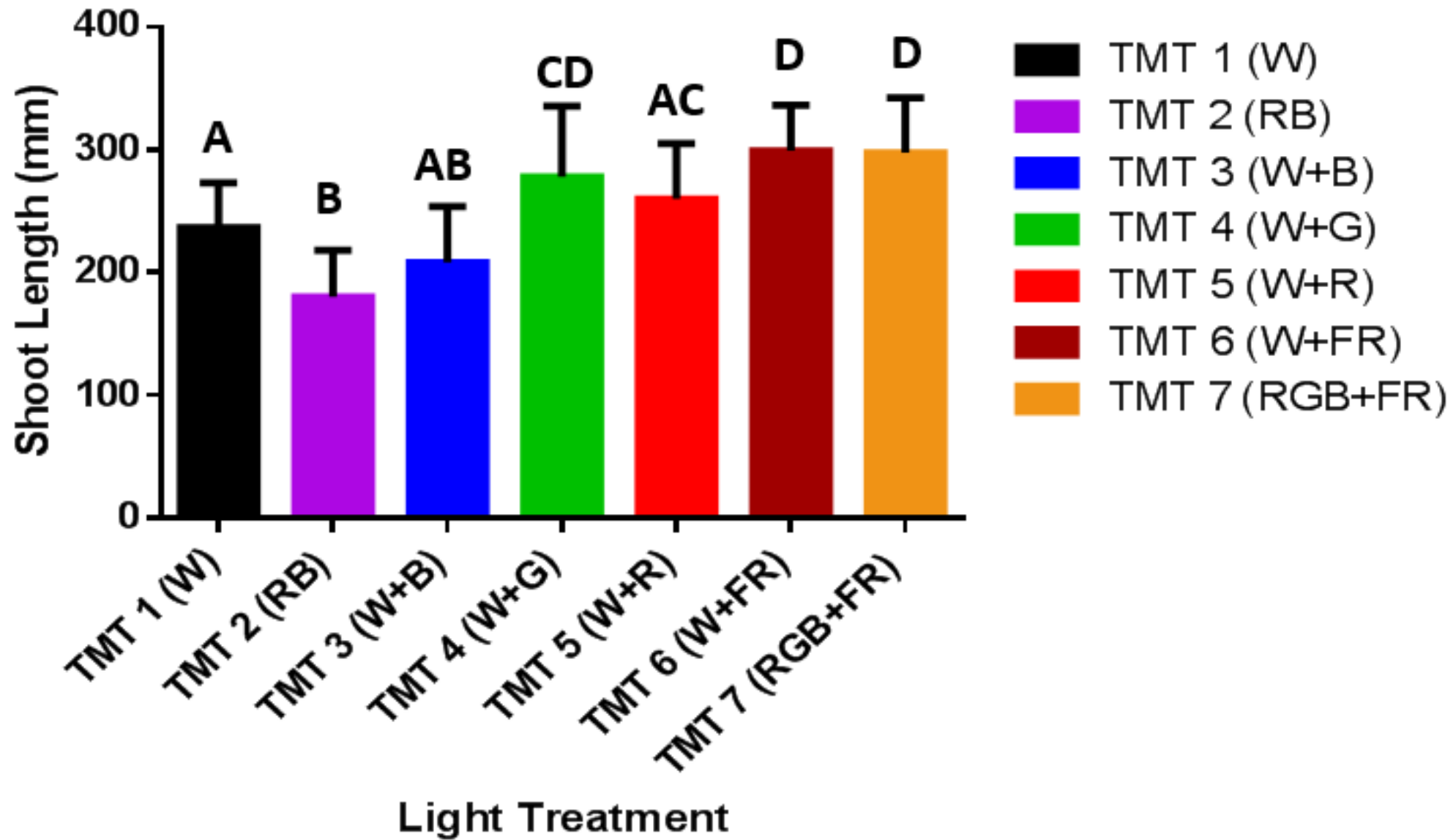
White + Far Red (745 nm)

Treatment 7

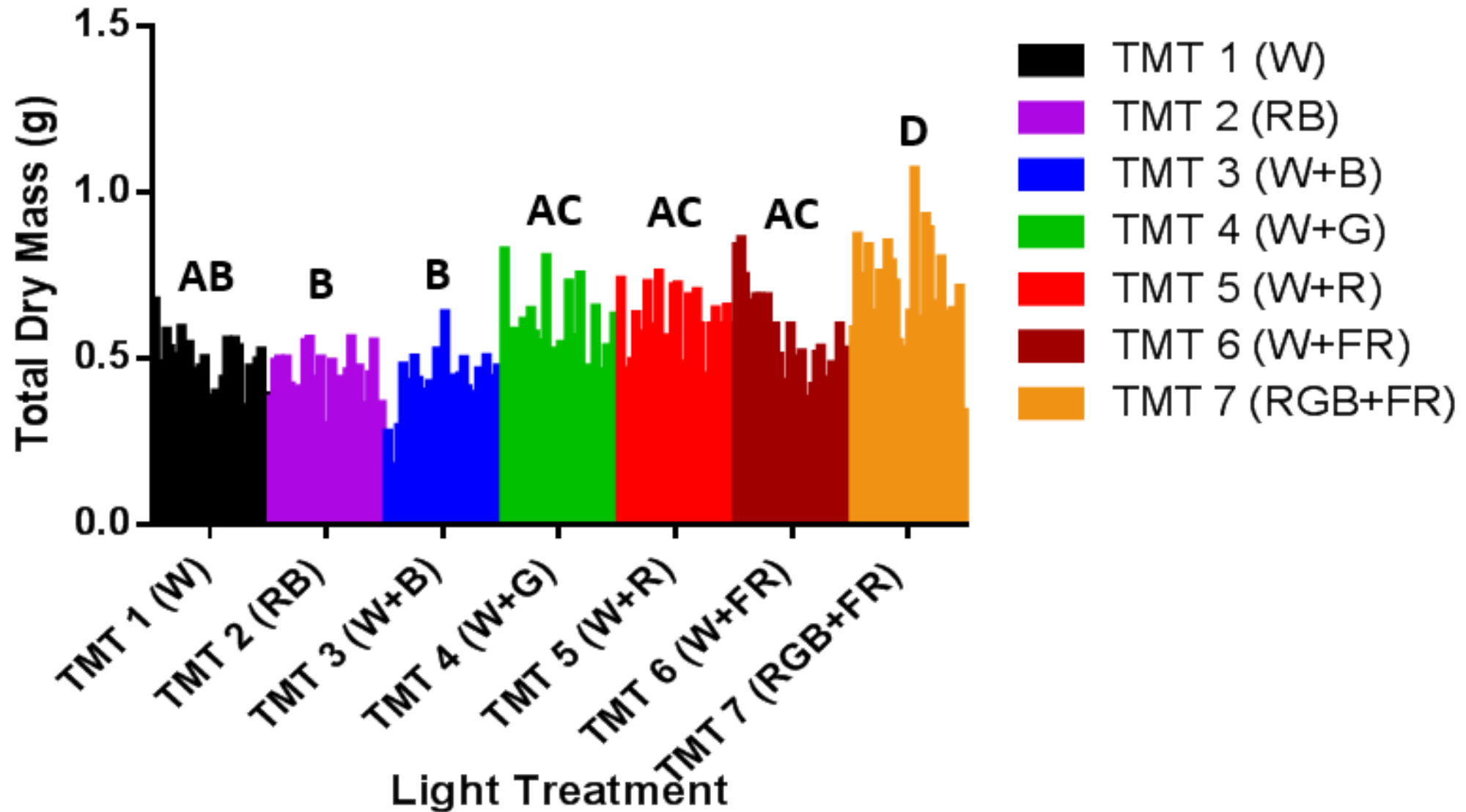


RGB + FR

Shoot Diameter (21 DAP)



Total Dry Mass (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)

Morphology



W



RB



W+B



W+G



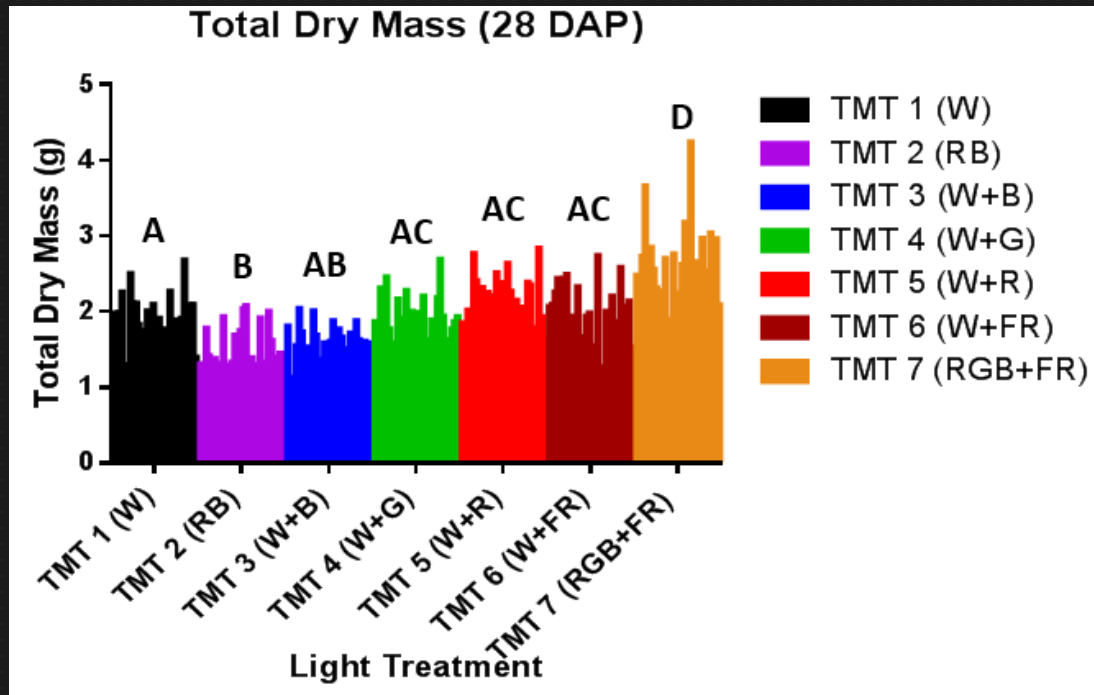
W+R



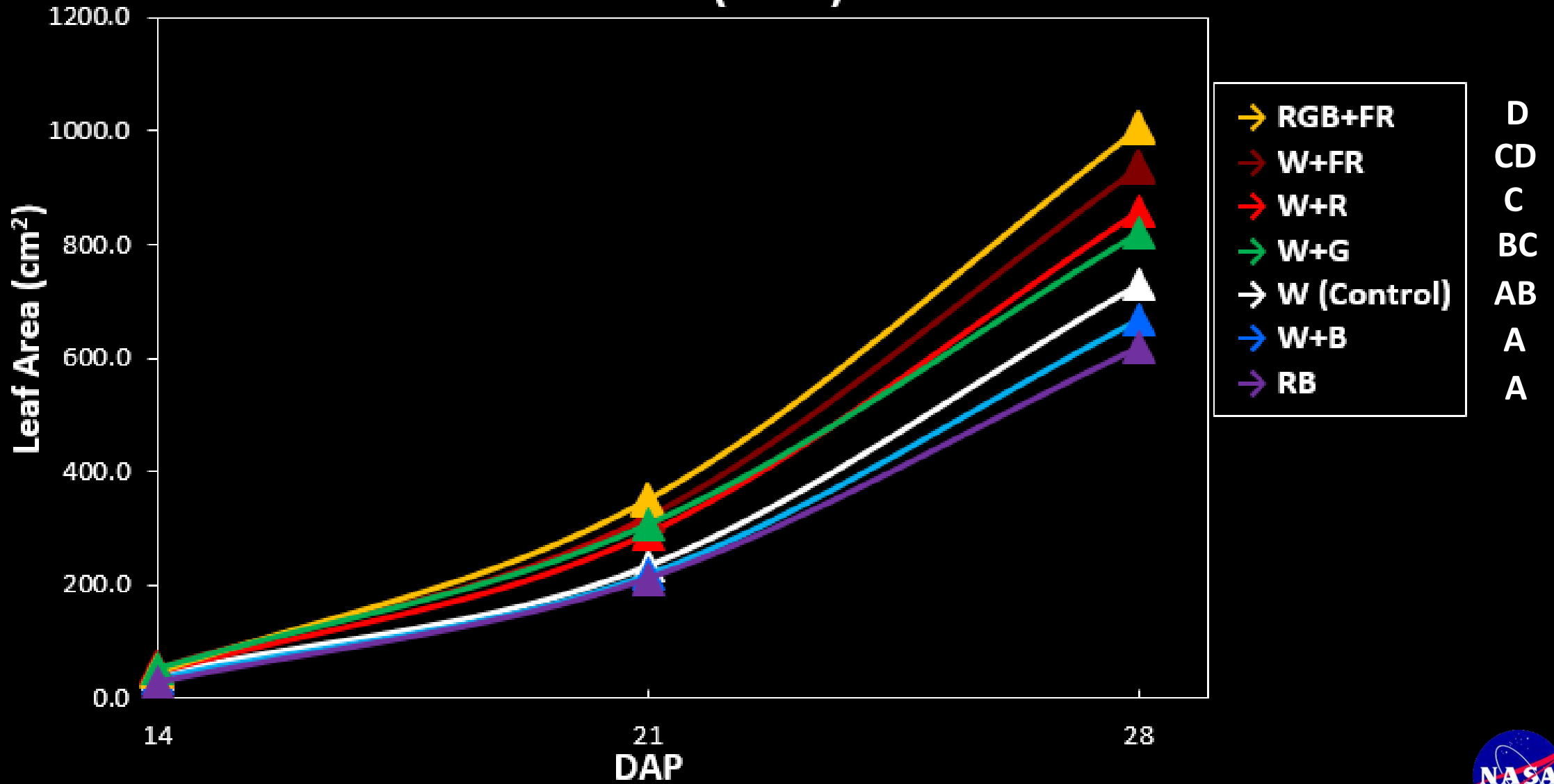
W+FR



RGB+FR



Leaf Area (cm²)





RB

W+FR

RGB+FR



Conclusion

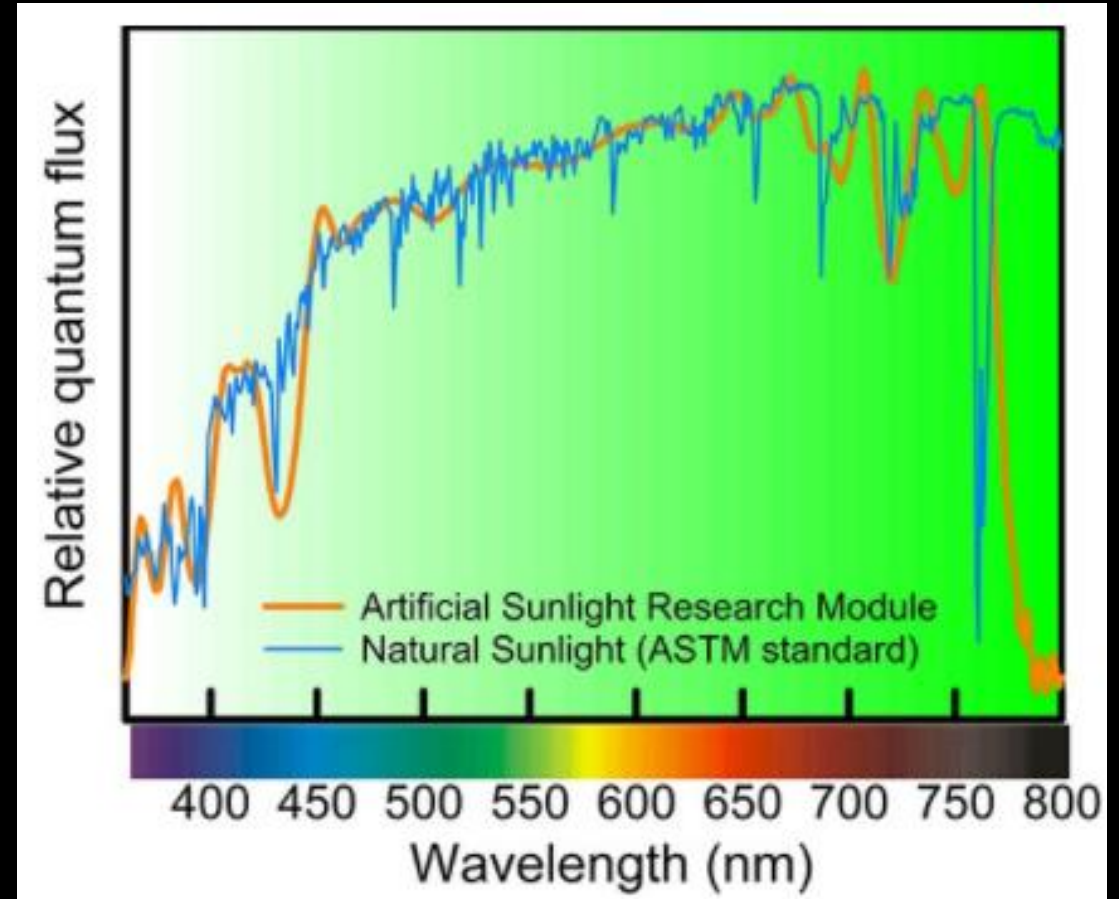
Supplementing WLEDs with equal amounts of light from various monochromatic LEDs was dependent on plant age and cycle progression.

Overall, this study showed WLED performance to be more beneficial for growth than RB light alone, but also RGB + FR at certain ratios can be even more beneficial than WLEDs.

Future in LED light Recipes



Artificial Sunlight Research Module (ASRM)



Spectral Comparisons

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





Gioia Massa



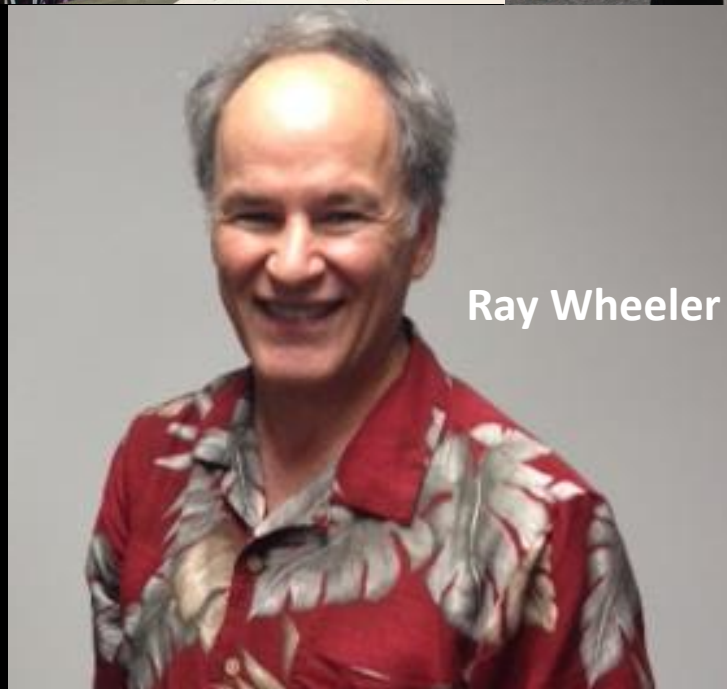
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