Whole Plant Candidate Crop Characterization Using Advanced Growth Chamber Technology

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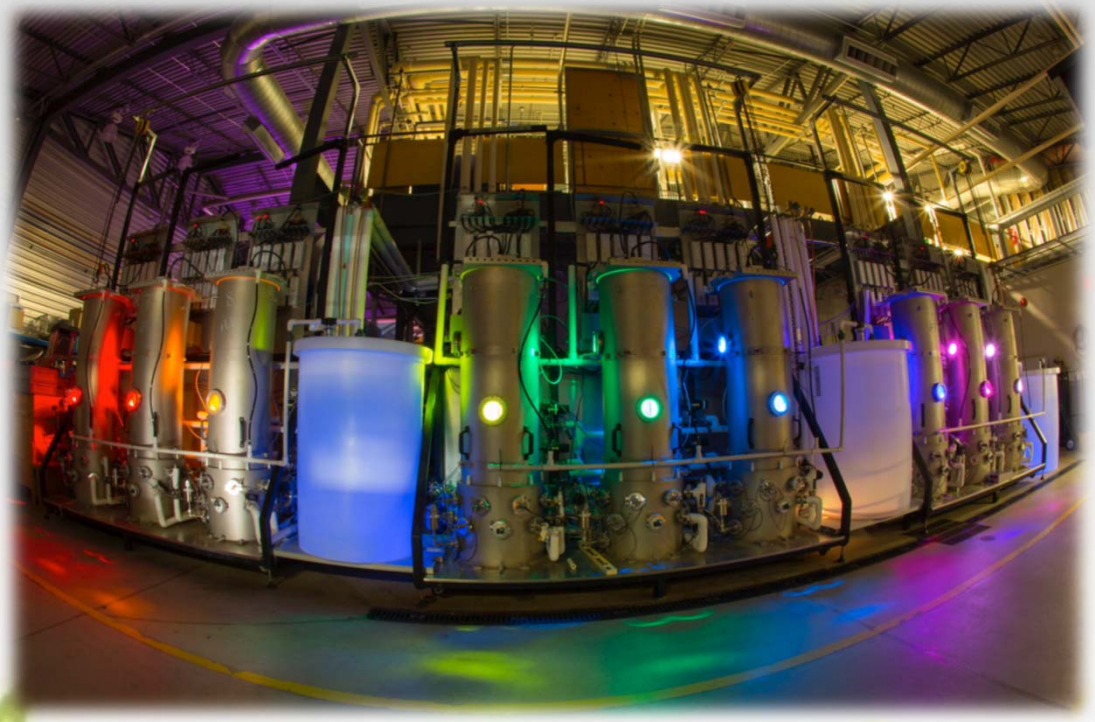
CESRF

Updated chamber technology

- 7 original water cooled LEDs replaced with 9 new 9-channel (UV to far red) water cooled LED array's



A collaboration between
CESRF,
CONVIRON,
and **Intravision Light Systems**
was established in order to develop
the next generation high resolution
sealed controlled environment system

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CESRF

Sealed Controlled Environment System

A precision tool to better study plant physiological responses manipulation of multiple variables including:

- Temperature
- Humidity
- Carbon dioxide
- Oxygen
- Light (quantity, quality)
- Nutrients
- Plant water status
- Insect predation
- Pathogen application/response
- Chemical application (pesticide, biocontrol, fertilizer)

Using a sealed environment chamber, we can answer the question "what happens to photosynthesis when you change _____?"

Hardware

Modified CONVIRON A1000 growth chamber

- New door and frame with multipoint closure and hermetic seal
- Specular aluminium interior cladding
- Mettler Toledo 32 kg 0.1g balance for ET measurement

HVAC

- Custom design with chilled and hot water heat exchangers
- Variable speed air flow with bottom up distribution

Control

- ARGUS control system

Lighting

- 2200 Watt water cooled LEDs with seven independently controlled channels
- UV (368 & 380), blue (448), white (5650K), green (568), red (655), far red (735)
- Wavelength and intensity programming through Argus interface

Preliminary Testing

Preliminary testing with a variety of plant species including:

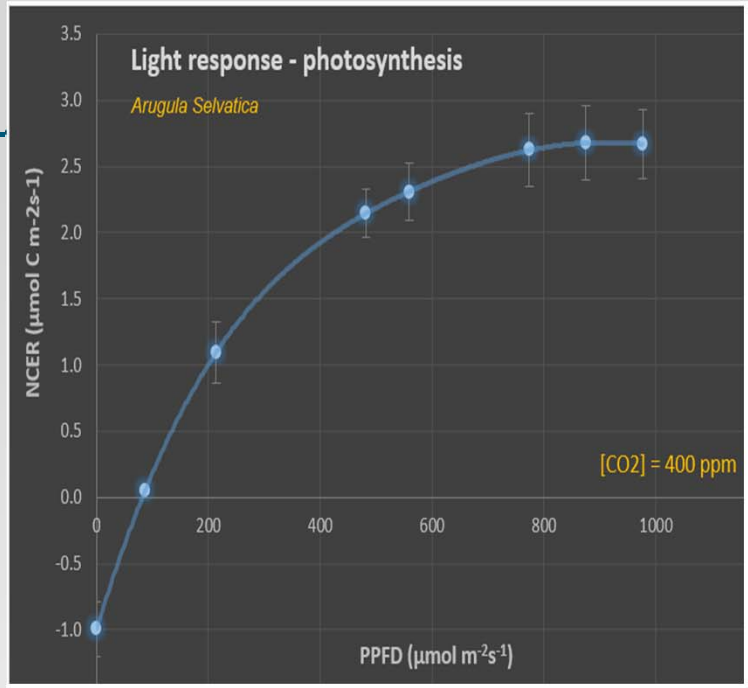
Capsicum annuum CV Mini Bell Red

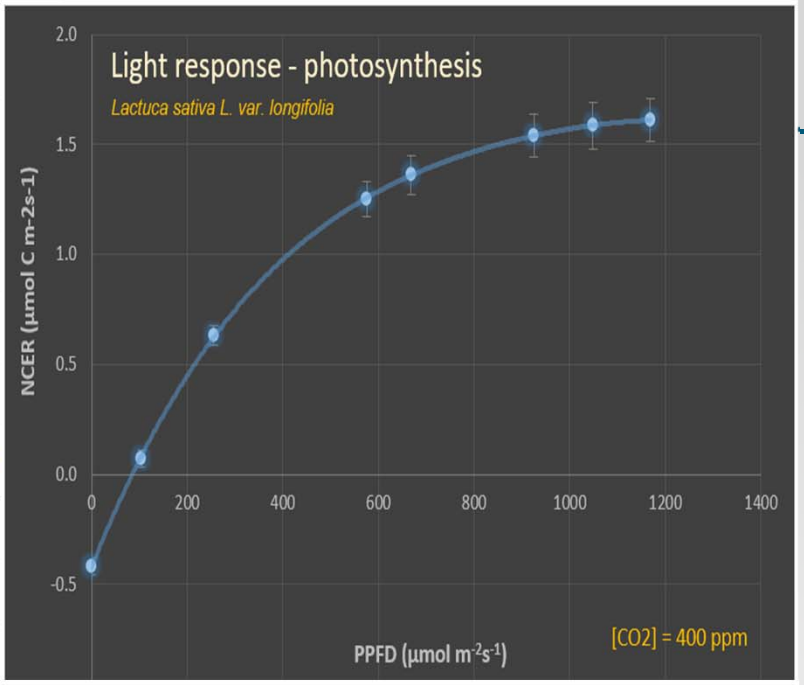
Solanum lycopersicum CV Red Robin

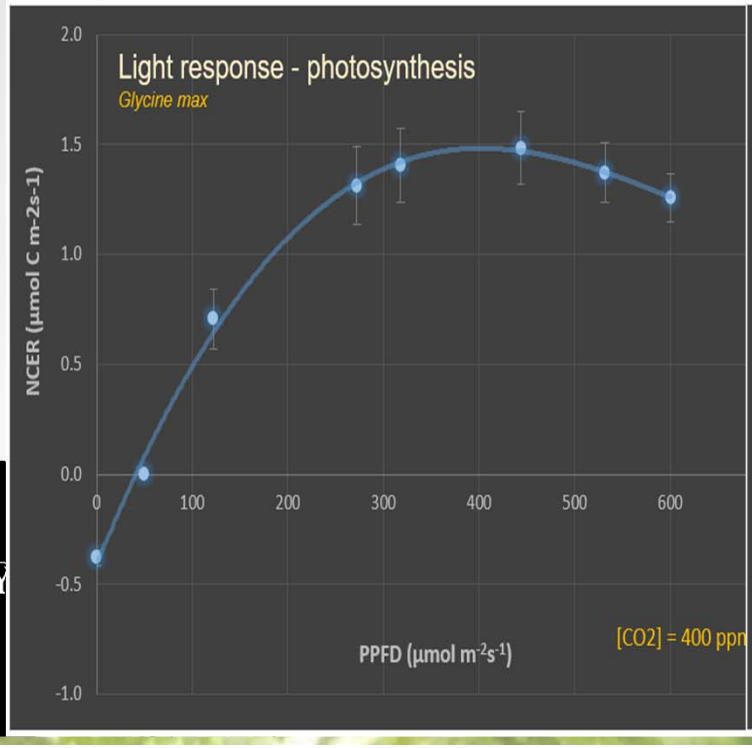
Lactuca sativa CV New Red Fire

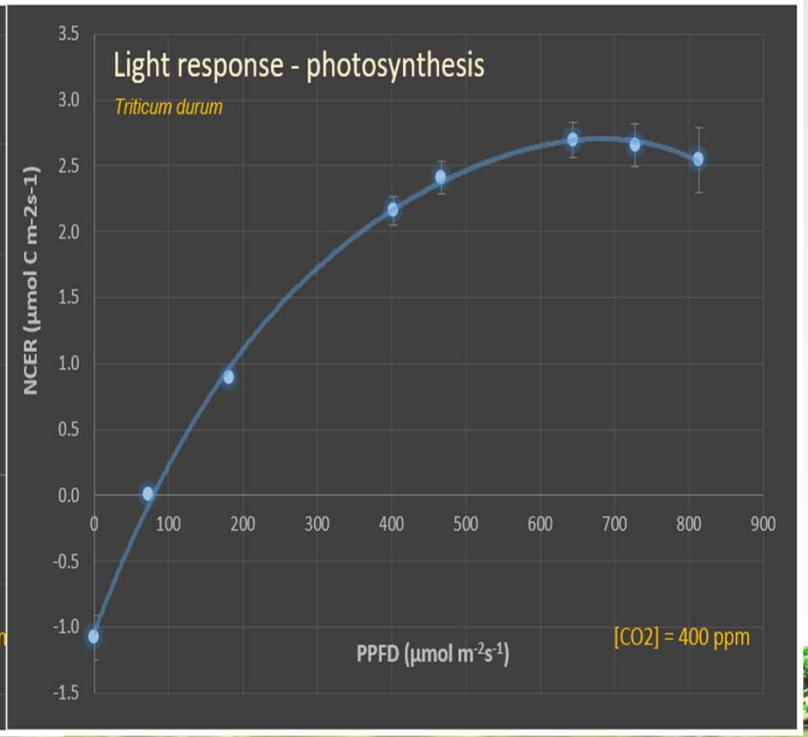
Notes

- All plants were 4 weeks old at the time of analysis
- Plants were grown in 6” pots in Sunshine mix #1
- All data replicated a minimum of 3 times - most were 5 reps
- Plant nursery was walk-in growth chamber 27D
- Fluorescent lighting, 23C, ~65% RH, PPFD ~300
- Actual values are not important – the relative response to the tested variables is what we are looking at in these graphs
- This type of information is needed for modelling to be able to predict yield and atmospheric stability – especially if environment control fluctuates during production
- Potential use modelling data to predictively use the HPC as a throttle for atmosphere control (amount of CO2 removed or O2 produced or water produced)
- Other parameters to be tested are VPD response and temperature response









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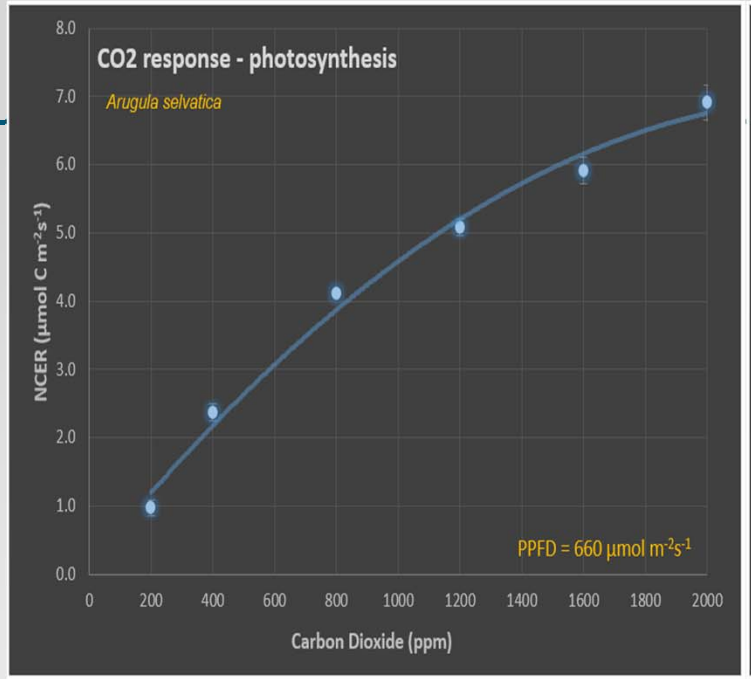
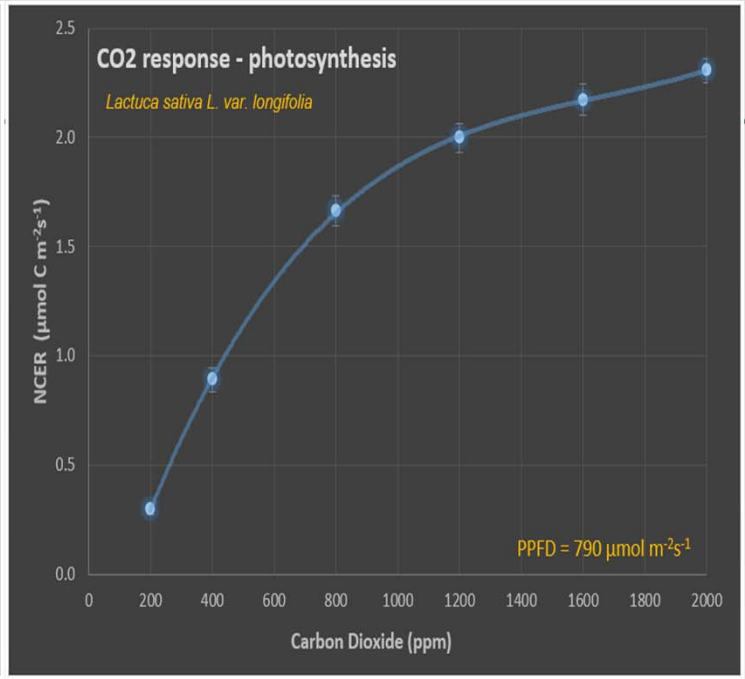
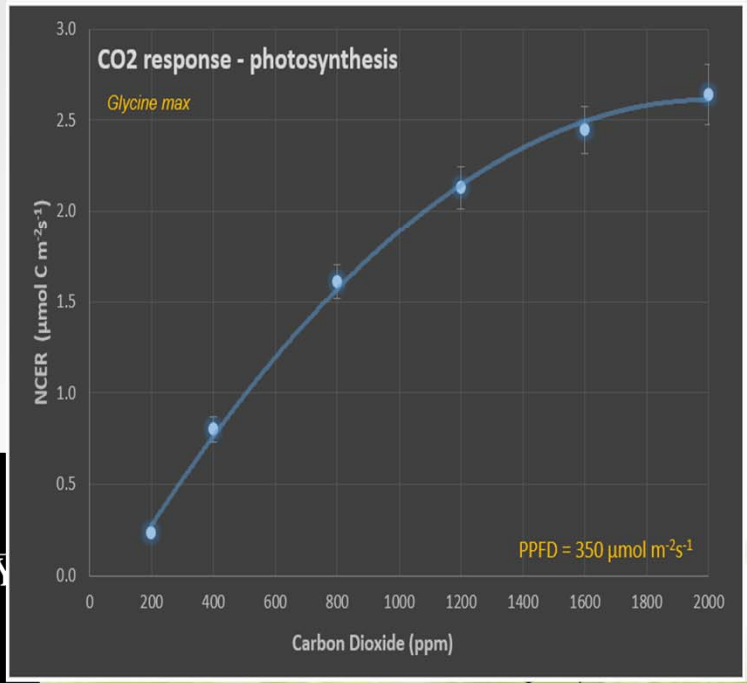
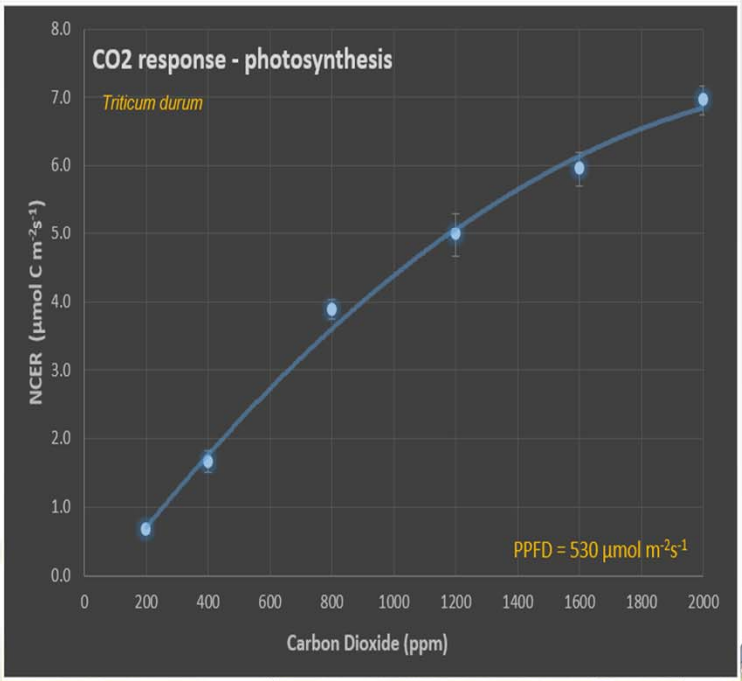
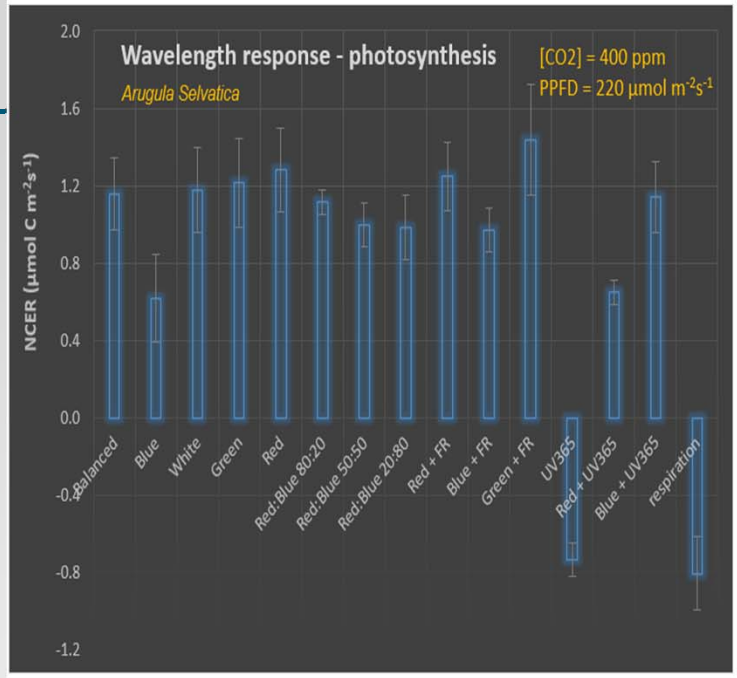
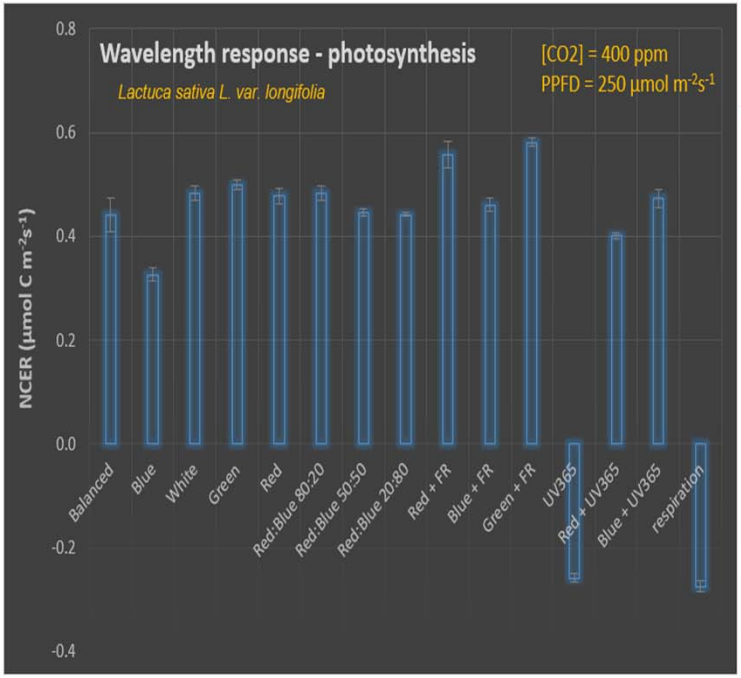

CO2 response - photosynthesis
Arugula selvatica
NCER (µmol C m-2s-1)
Carbon Dioxide (ppm)
PPFD = 660 µmol m-2s-1


CO2 response - photosynthesis
Lactuca sativa L. var. longifolia
NCER (µmol C m-2s-1)
Carbon Dioxide (ppm)
PPFD = 790 µmol m-2s-1


CO2 response - photosynthesis
Glycine max
NCER (µmol C m-2s-1)
Carbon Dioxide (ppm)
PPFD = 350 µmol m-2s-1


CO2 response - photosynthesis
Triticum durum
NCER (µmol C m-2s-1)
Carbon Dioxide (ppm)
PPFD = 530 µmol m-2s-1


Wavelength response - photosynthesis
[CO2] = 400 ppm
PPFD = 220 µmol m-2s-1
Arugula Selvatica
NCER (µmol C m-2s-1)
2.0
1.6
1.2
0.8
0.4
0.0
-0.4
-0.8
-1.2
Balanced
Blue
White
Green
Red
Red:Blue 80:20
Red:Blue 50:50
Red:Blue 20:80
Red + FR
Blue + FR
Green + FR
UV365
Red + UV365
Blue + UV365
respiration


Wavelength response - photosynthesis
[CO2] = 400 ppm
PPFD = 250 µmol m-2s-1
Lactuca sativa L. var. longifolia
NCER (µmol C m-2s-1)
0.8
0.6
0.4
0.2
0.0
-0.2
-0.4
Balanced
Blue
White
Green
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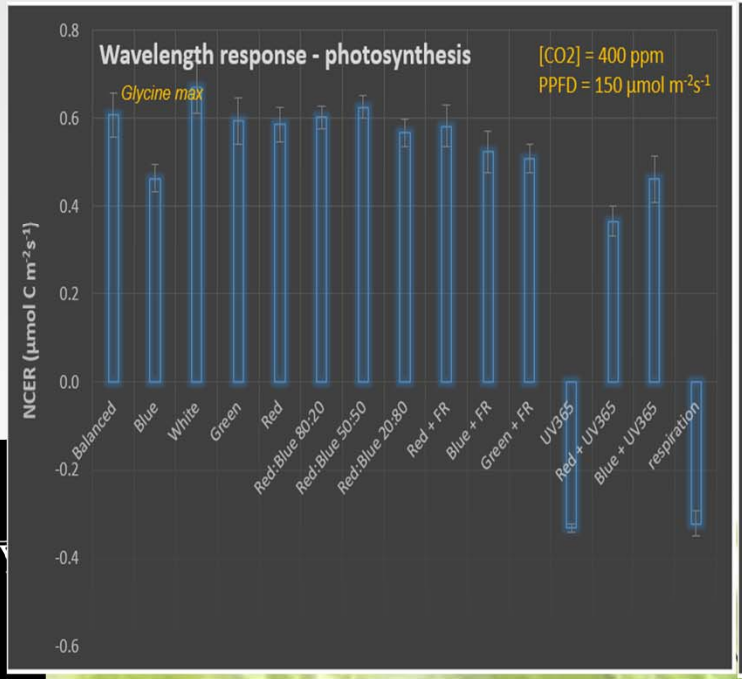
Wavelength response - photosynthesis
[CO2] = 400 ppm
PPFD = 150 µmol m-2s-1
Glycine max
NCER (µmol C m-2s-1)
0.8
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
Balanced
Blue
White
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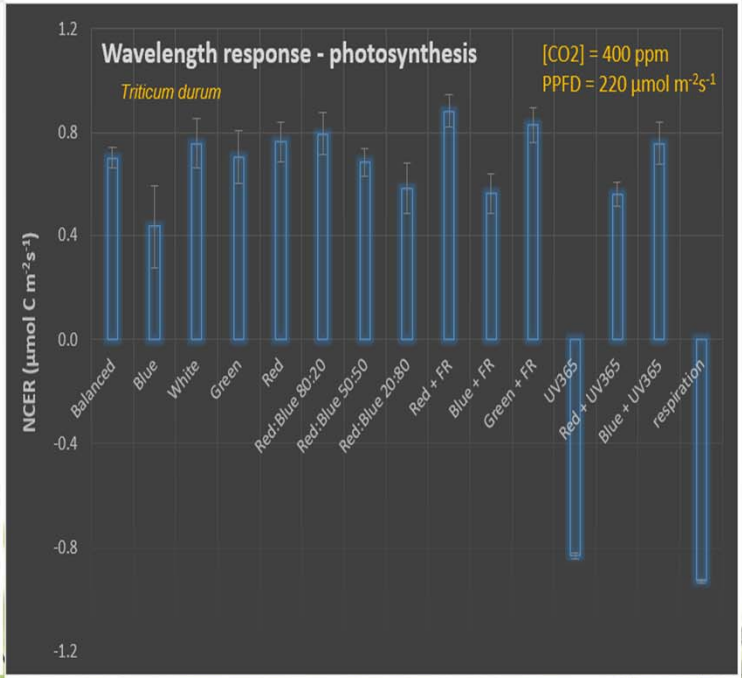
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Triticum durum
NCER (µmol C m-2s-1)
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0.8
0.4
0.0
-0.4
-0.8
-1.2
Balanced
Blue
White
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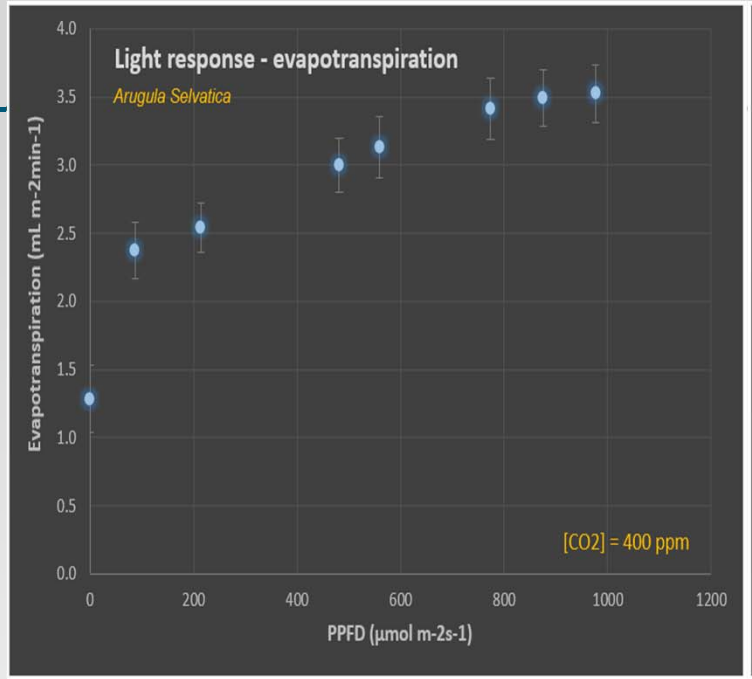
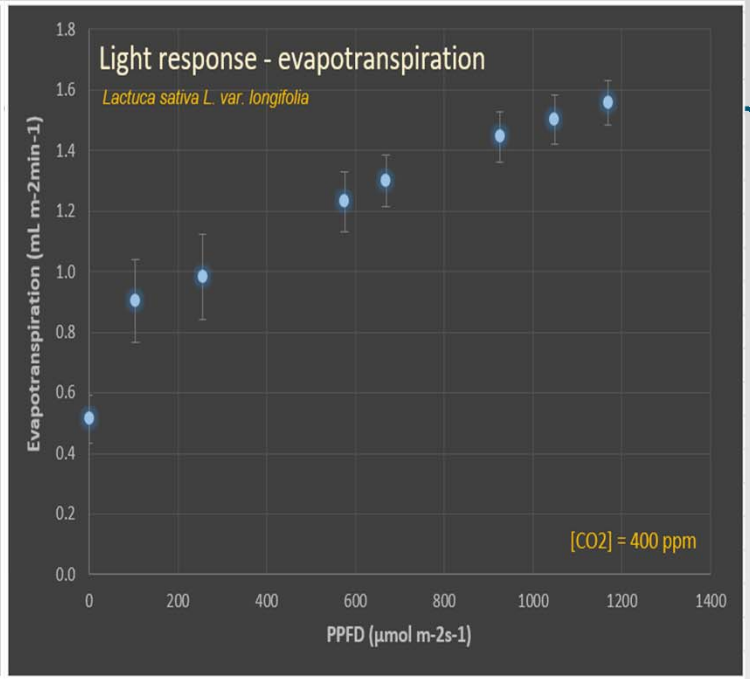

Light response - evapotranspiration
Arugula Selvatica
Evapotranspiration (mL m-2min-1)
PPFD (µmol m-2s-1)
[CO2] = 400 ppm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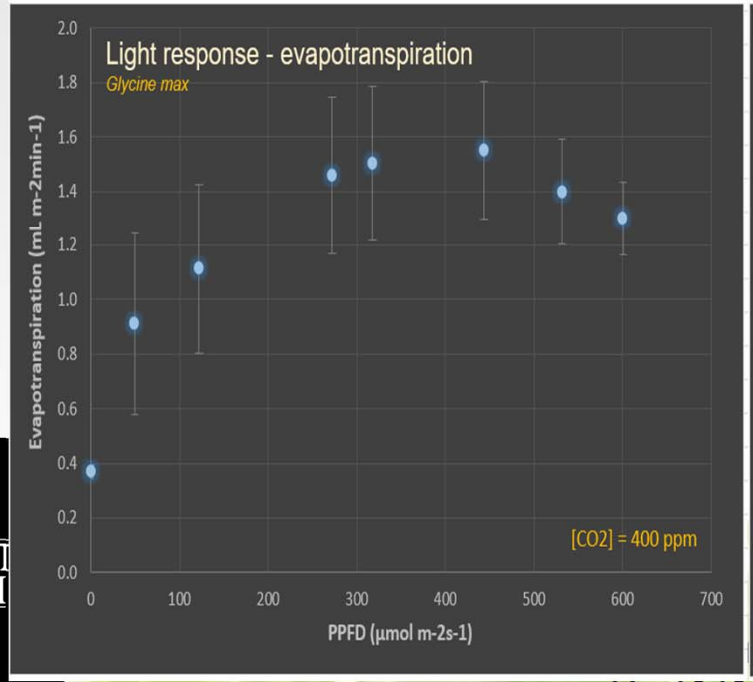
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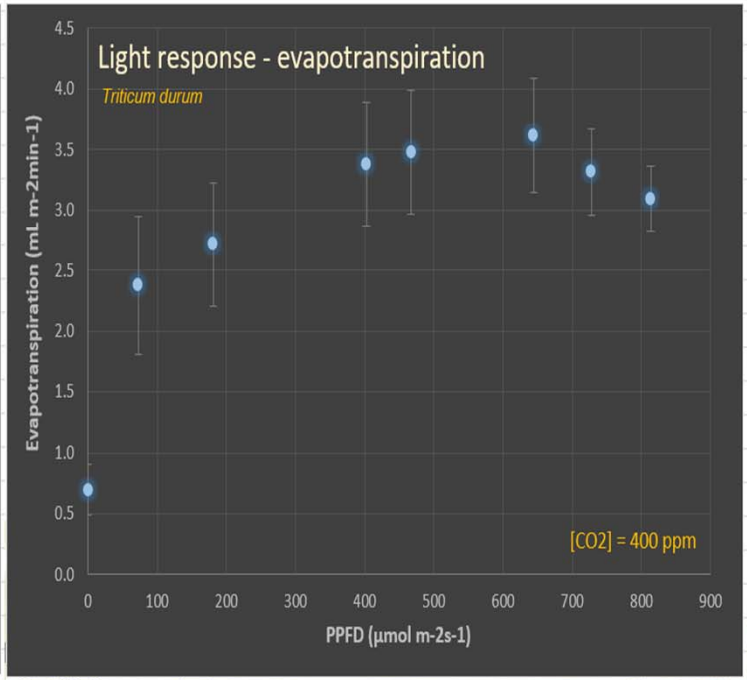
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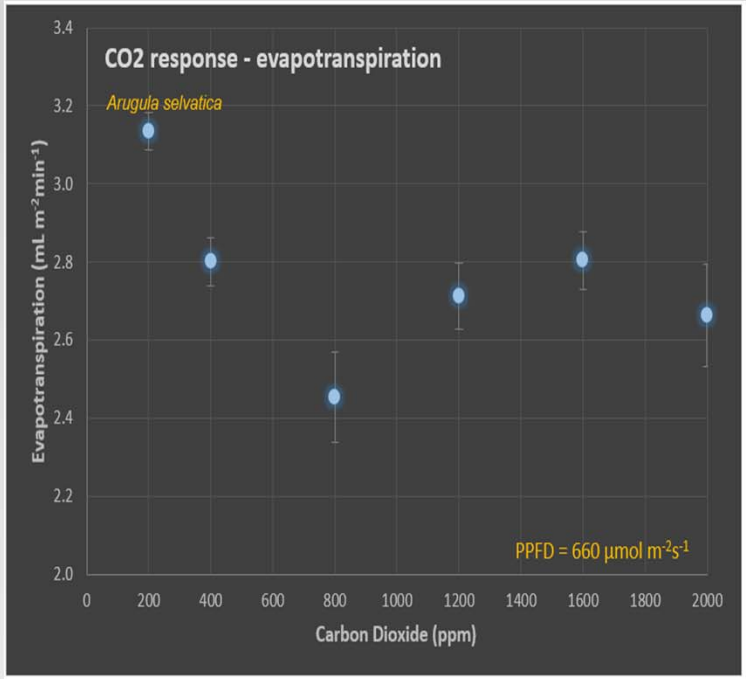
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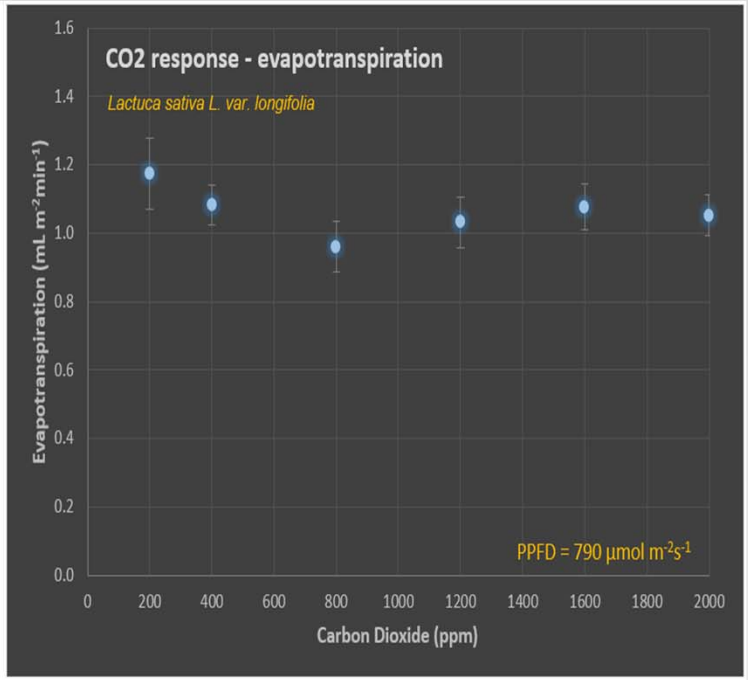
Carbon Dioxide (ppm)
PPFD = 660 µmol m-2s-1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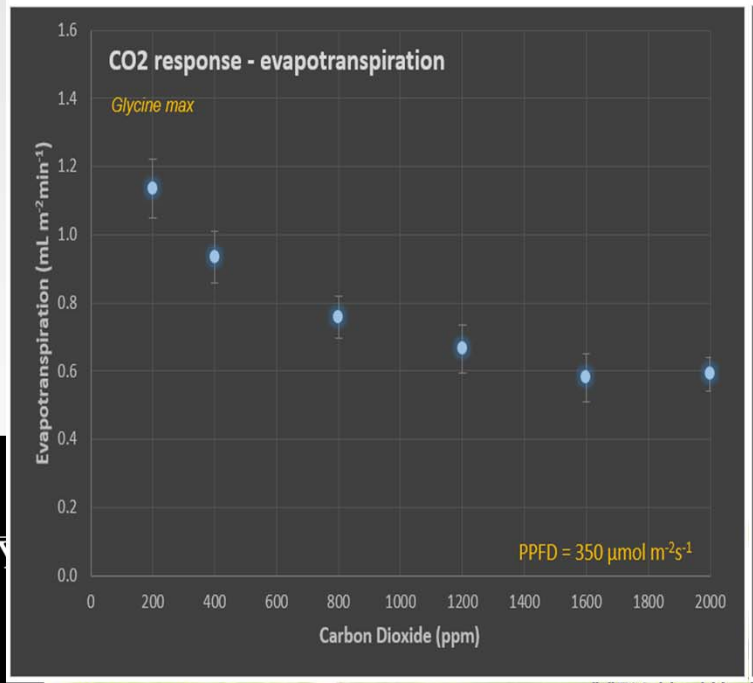
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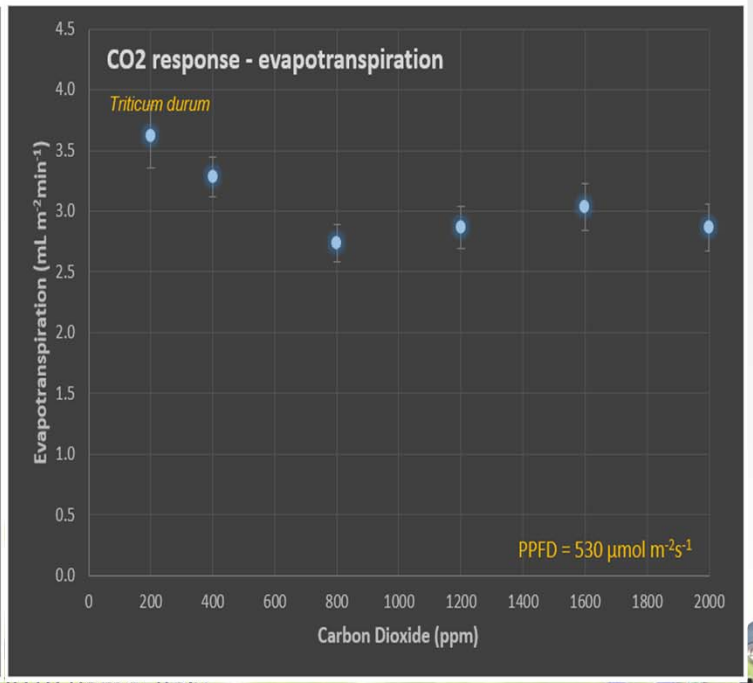
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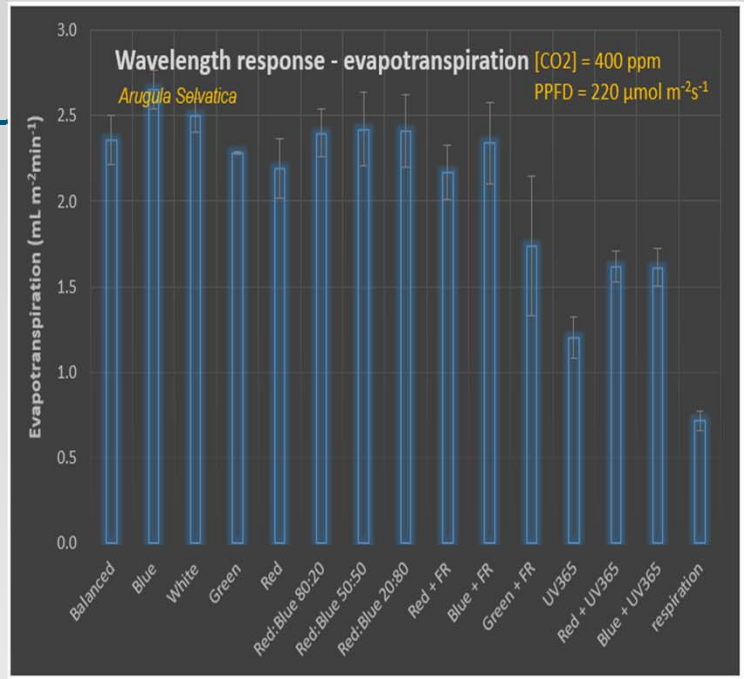
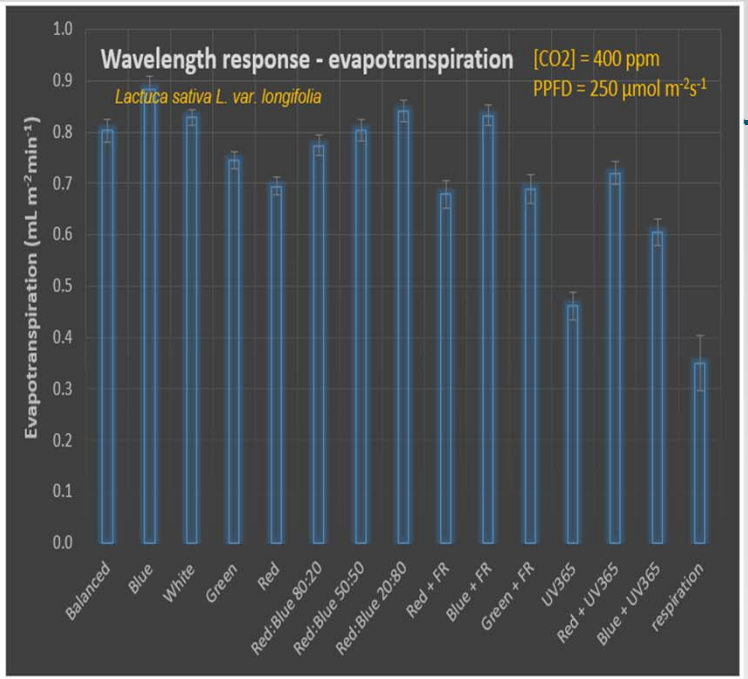

Wavelength response - evapotranspiration [CO2] = 400 ppm
Arugula Selvatica
PPFD = 220 µmol m-2s-1
Evapotranspiration (mL m-2min-1)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Balanced
Blue
White
Green
Red
Red:Blue 80:20
Red:Blue 50:50
Red:Blue 20:80
Red + FR
Blue + FR
Green + FR
UV365
Red + UV365
Blue + UV365
respiration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Lactuca sativa L. var. longifolia
PPFD = 250 µmol m-2s-1
Evapotranspiration (mL m-2min-1)
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Balanced
Blue
White
Green
Red
Red:Blue 80:20
Red:Blue 50:50
Red:Blue 20:80
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Green + FR
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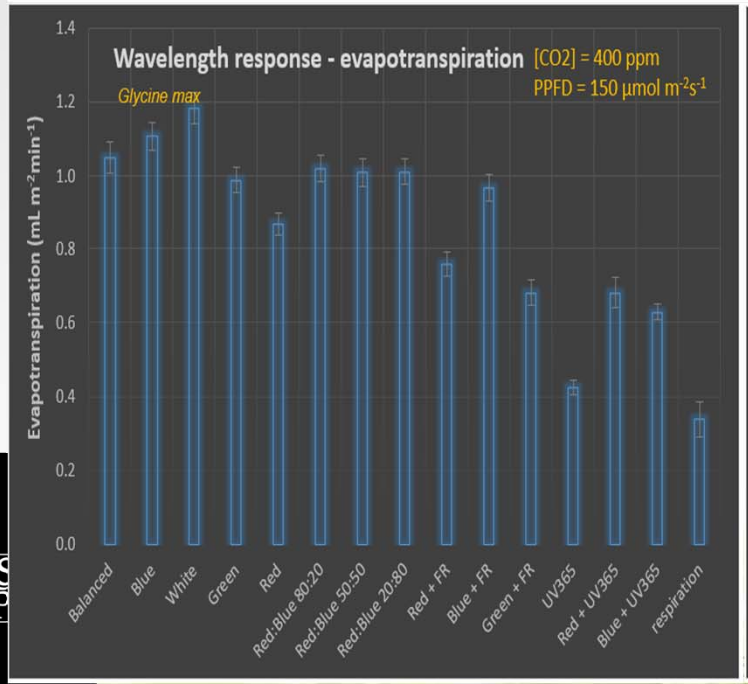
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Glycine max
PPFD = 150 µmol m-2s-1
Evapotranspiration (mL m-2min-1)
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Balanced
Blue
White
Green
Red
Red:Blue 80:20
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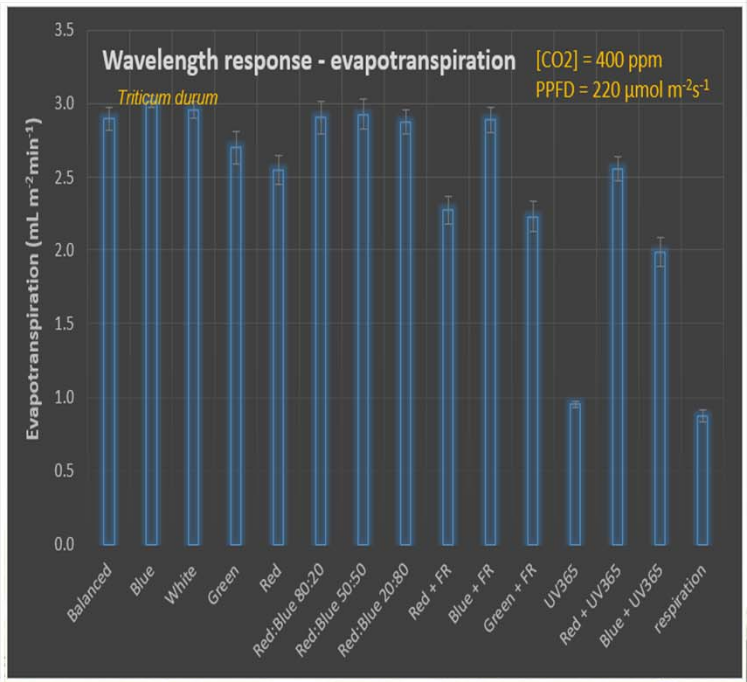
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Evapotranspiration (mL m-2min-1)
3.5
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2.5
2.0
1.5
1.0
0.5
0.0
Balanced
Blue
White
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Red:Blue 80:20
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Red:Blue 20:80
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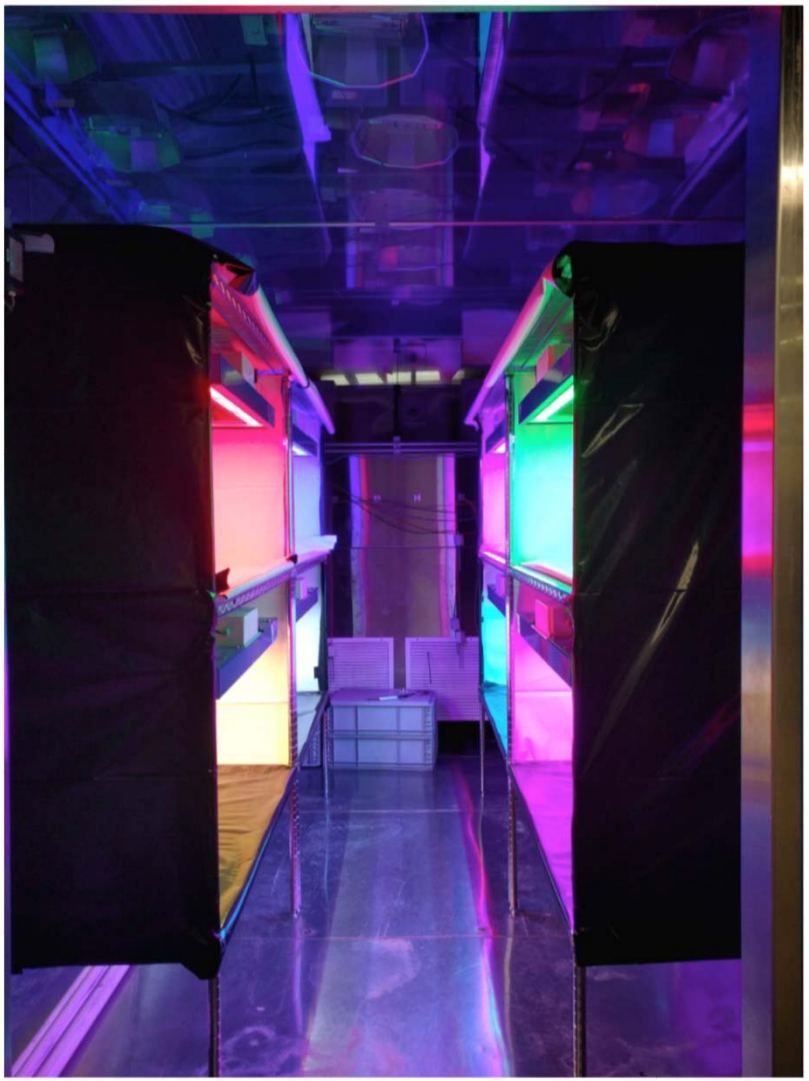
Phyto-pharmaceutical studies

One original ‘Guelph BlueBox’ chamber has been retrofitted with multi-channel, high-intensity water-cooled LEDs in compartments to study light responses related to the production of breast cancer drugs in tobacco.



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Inner canopy lighting

Early evidence suggests vertical stratification of secondary metabolite production in cannabis flower buds in response to sub-canopy lighting

Ongoing/Next Steps

- Examine relationships among environment variables in terms of plant responses
- Develop environment control recipes that reliably achieve predictable results in secondary metabolites such as taste and medicinal compounds
- Design more economic technical solutions for controlled environment systems