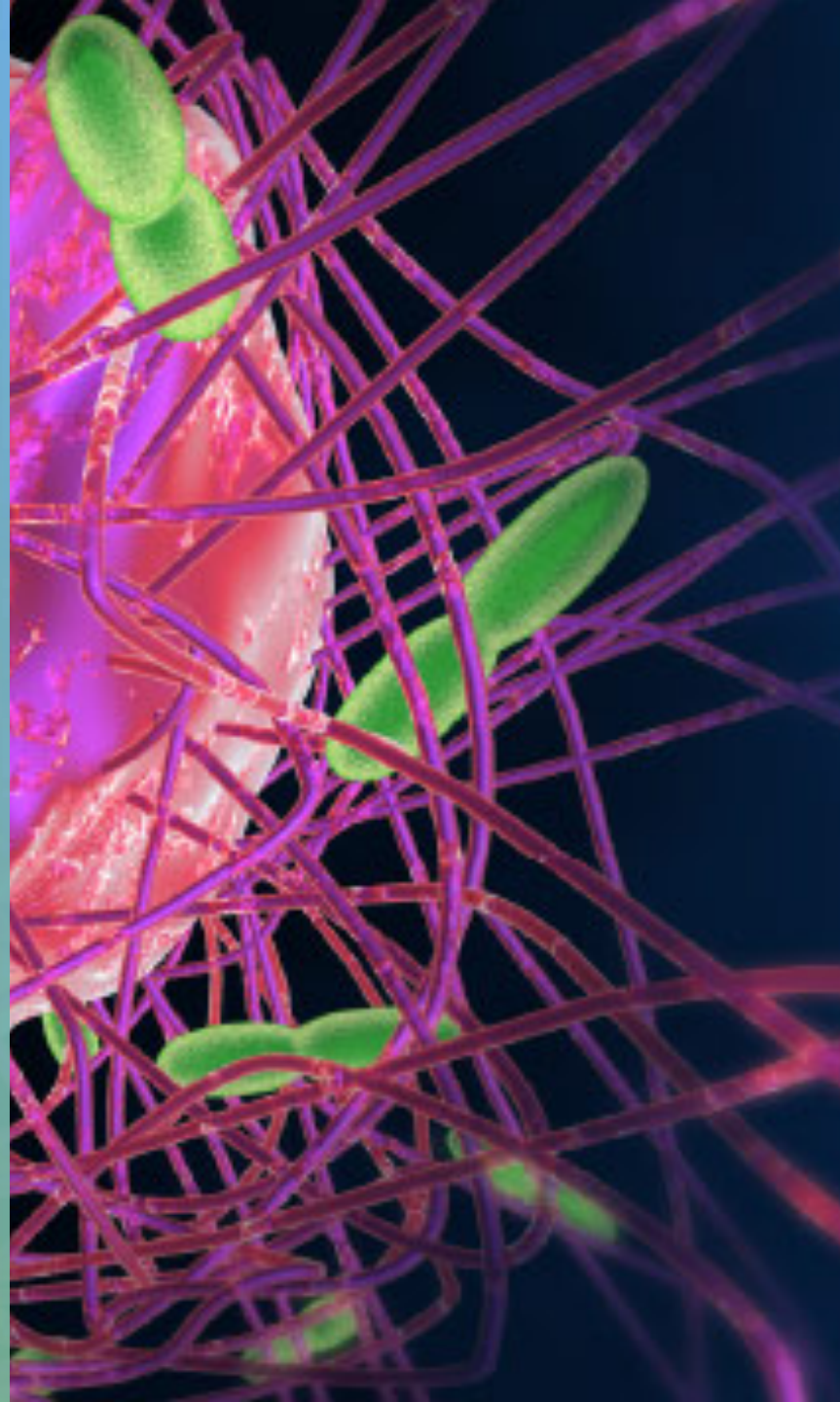
Vienna BioCenter

CORE FACILITIES



PLANT STRESS SYMPTOMS INVESTIGATION

Hypothesis: Photooxidative stress caused by nutrient (Pi?) deficiency?

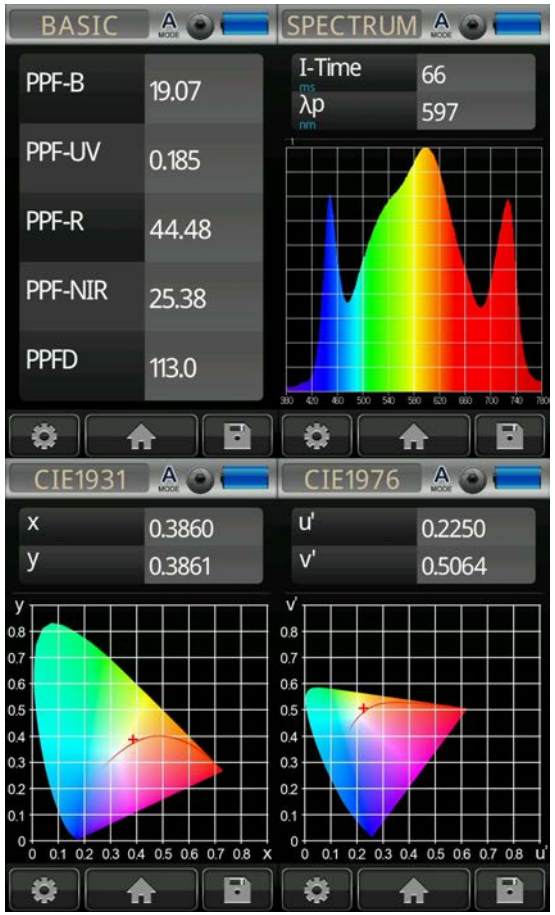
VBCF PlantS Facility, 10th December 2019

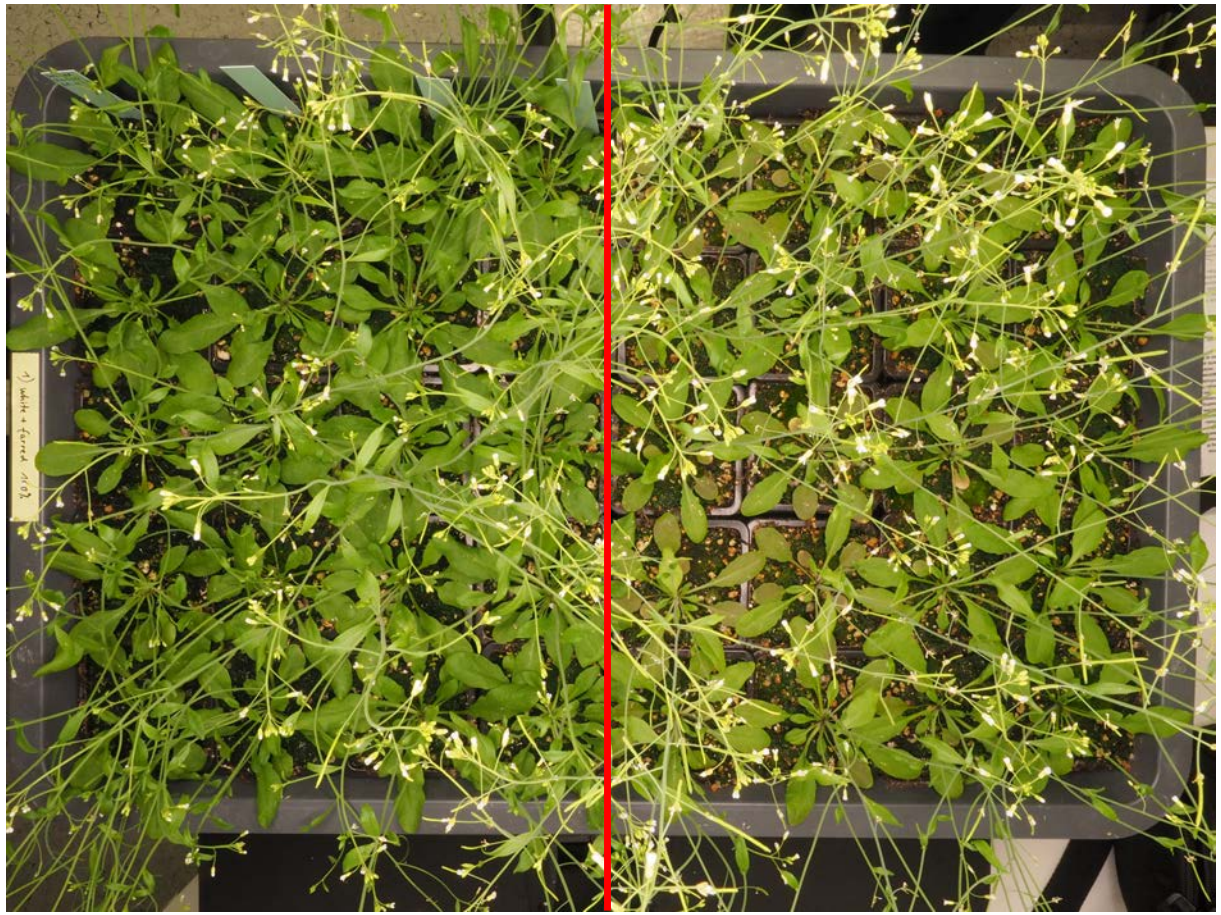
Vienna BioCenter
CORE FACILITIES

SETUP

- Location: MFPL 8th floor, phytotron #21
- Spectrum: variable (see individual slides)
- Intensity: see PPFD value in the respective graph/slide
- Soil: Gramoflor 2006, perlite 1:4, not sieved.
- A.th. Col-0. Sowing date: 30th October 2019
- Sample size: LED spectrum exp. & flowering time n=40; treatment n=20
- Treatment: „WUXAL Super“ fertilizer (NPK 8+8+6), 2mL/L, 1x treatment (top watering), 26DAS (days after sowing), left side only. Right side untreated.
- Pictures: taken 34DAS

1. WHITE + FR735

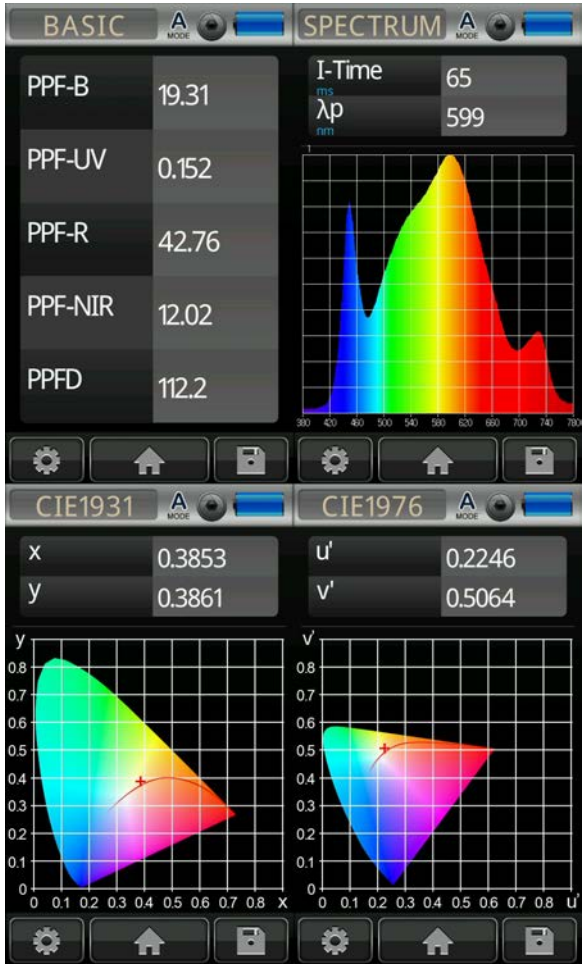


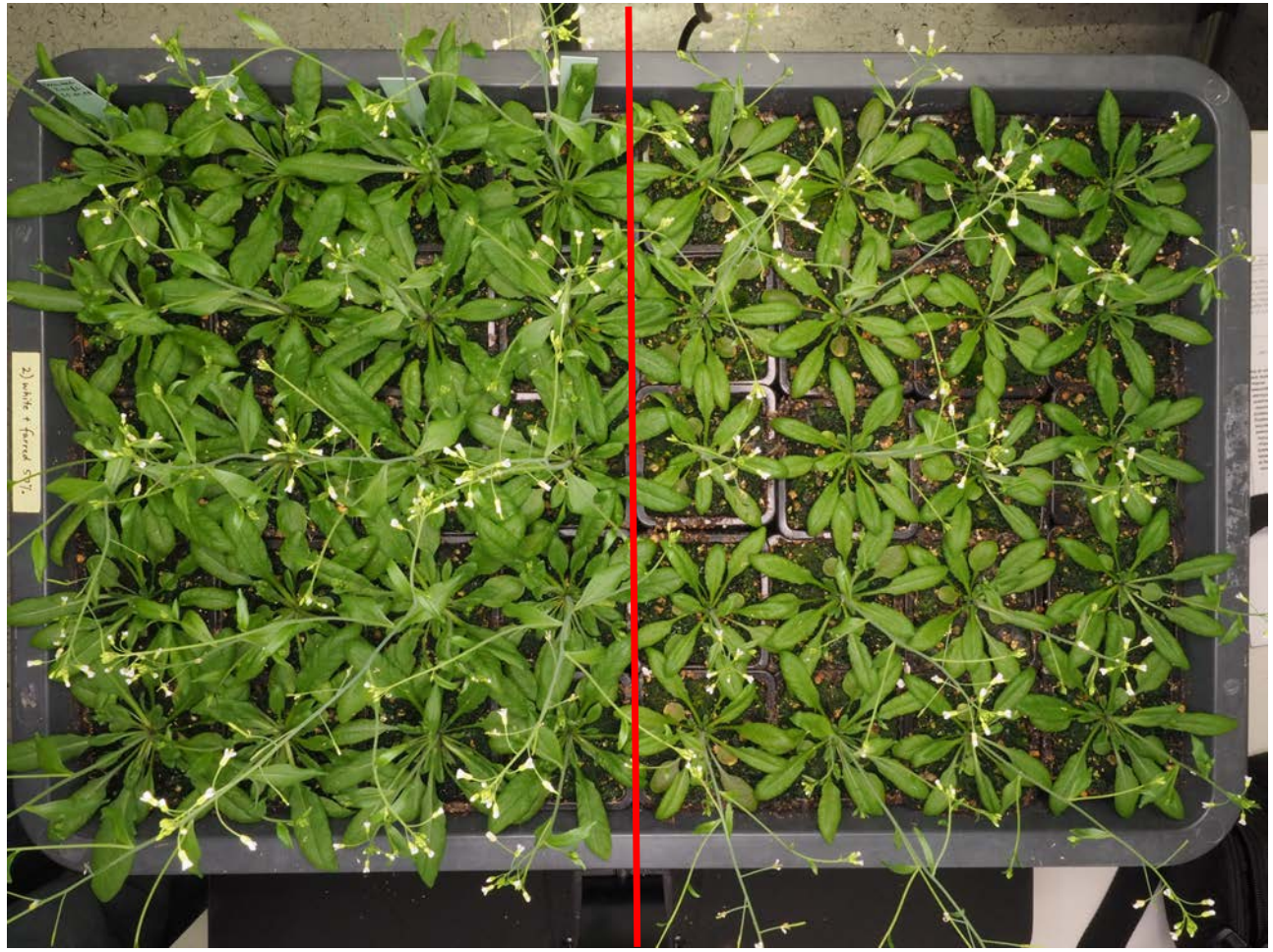


fertilized control

- Spectrum: White LEDs (100%)
  plus Far-red_735nm (100%) only

2. WHITE + FR735 50%

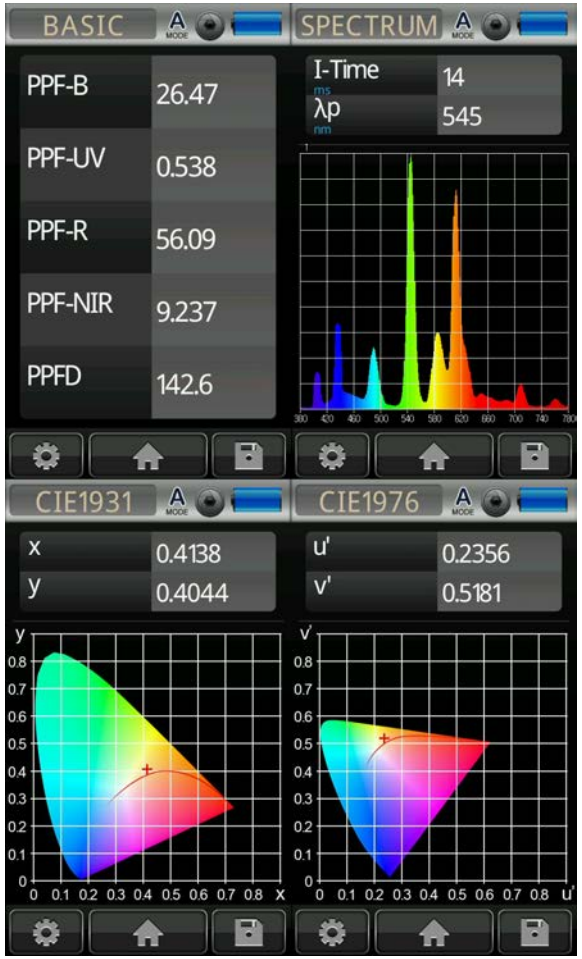


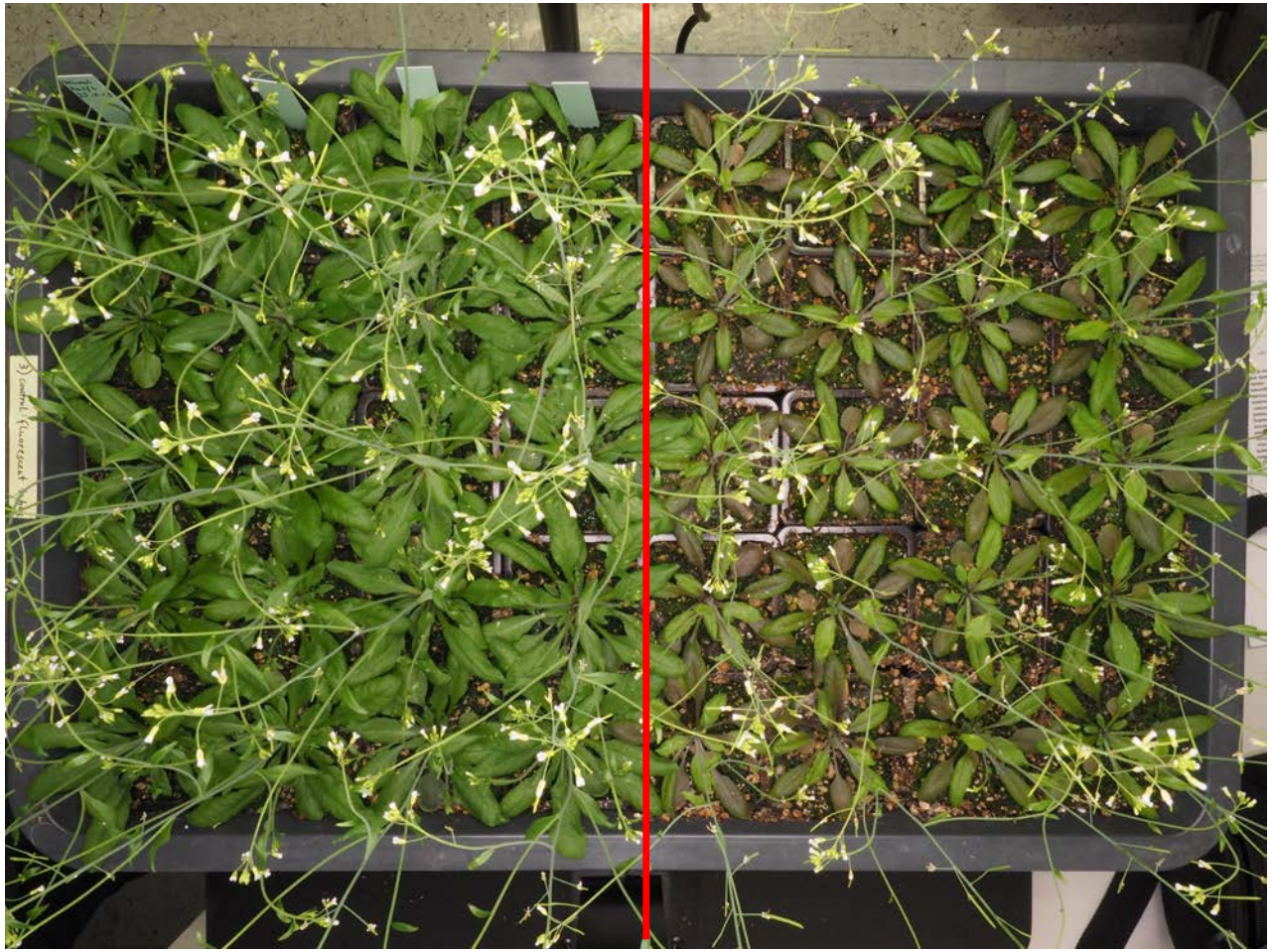


fertilized control

- Spectrum: White LEDs (100%) plus Far-red_735nm (50%) only

3. CONTROL: FLUO TUBE

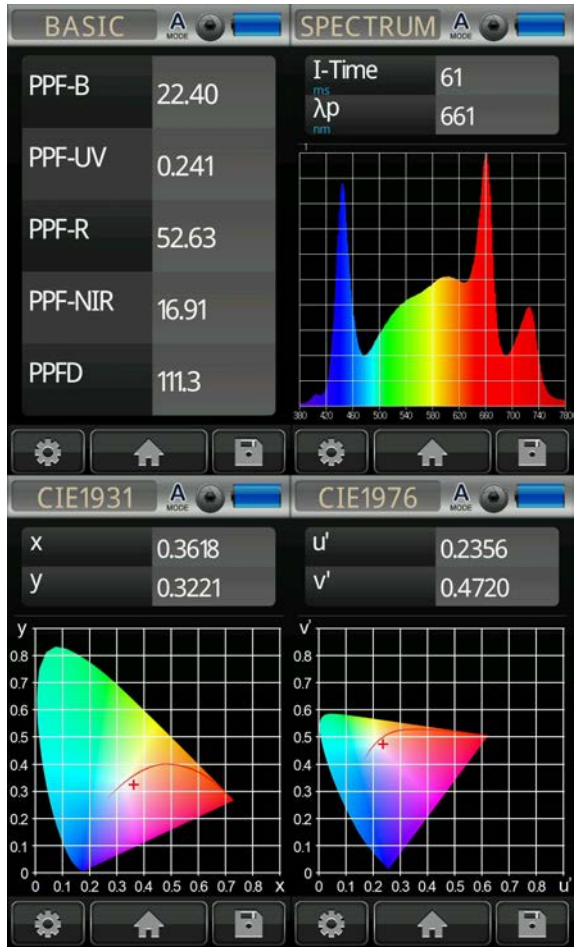


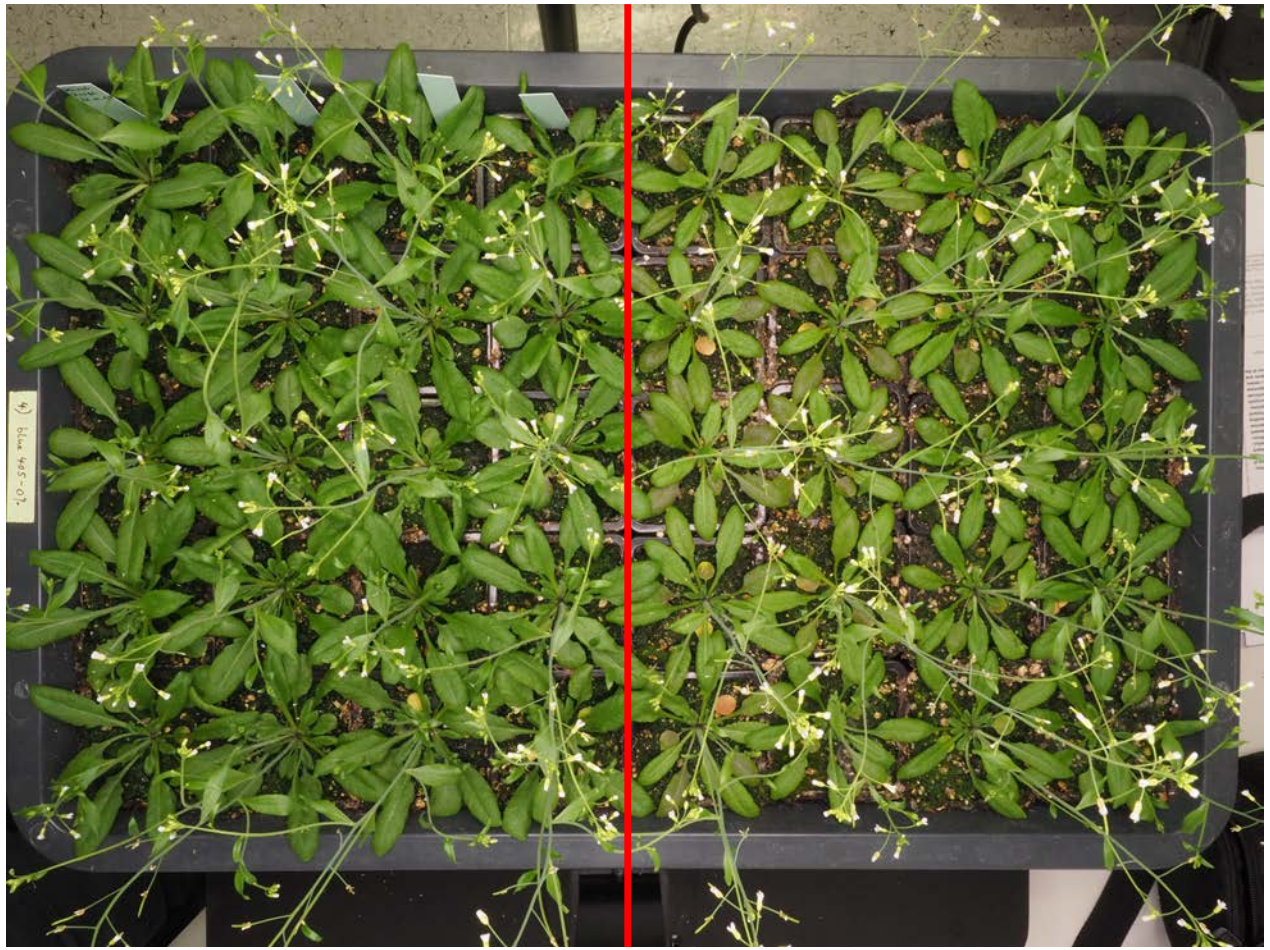


fertilized control

- Spectrum: MFPL T5 fluorescent tubes (4 pc.) control; not modified.

4. B405 0%

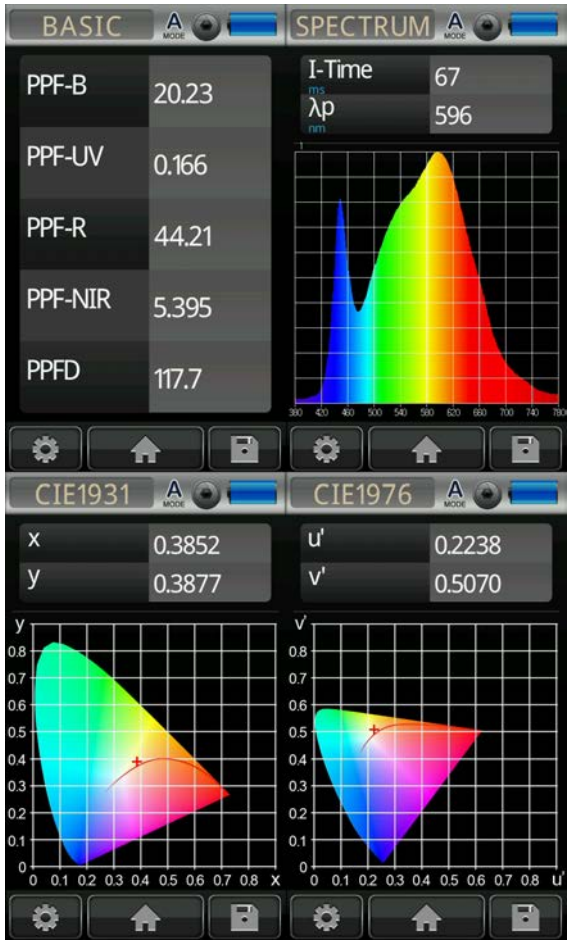


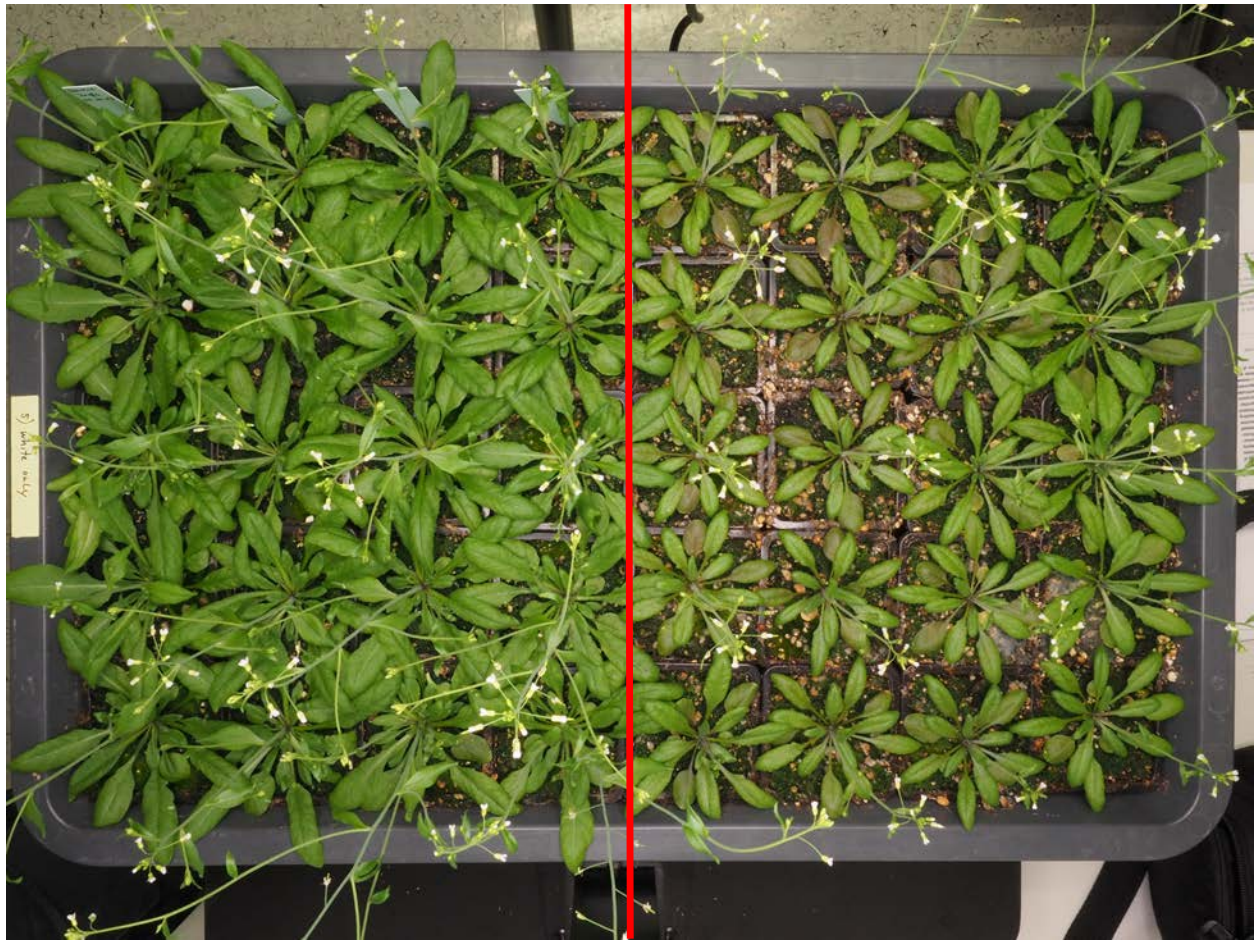


fertilized control

- Spectrum: Full LED spectrum; Blue_405nm cut to 0%.

5. WHITE ONLY



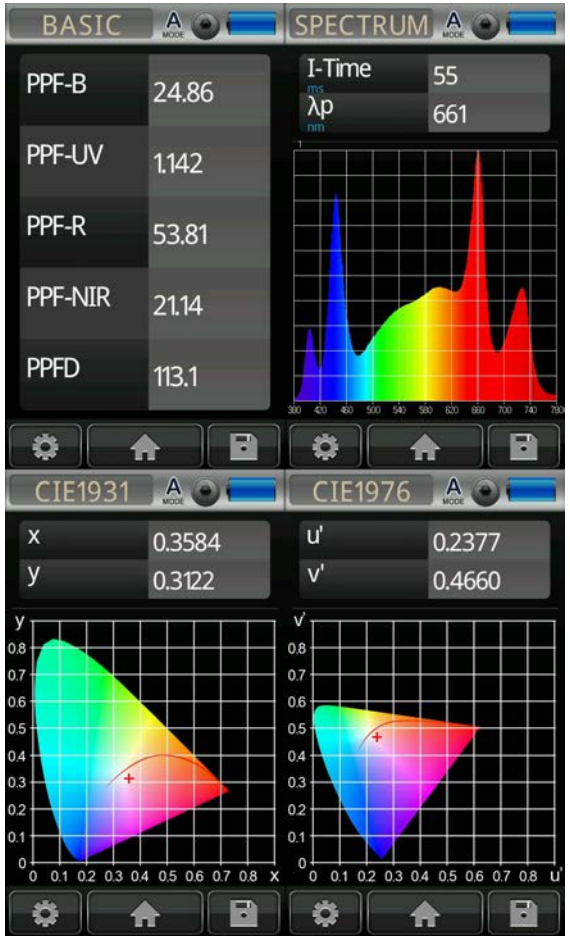


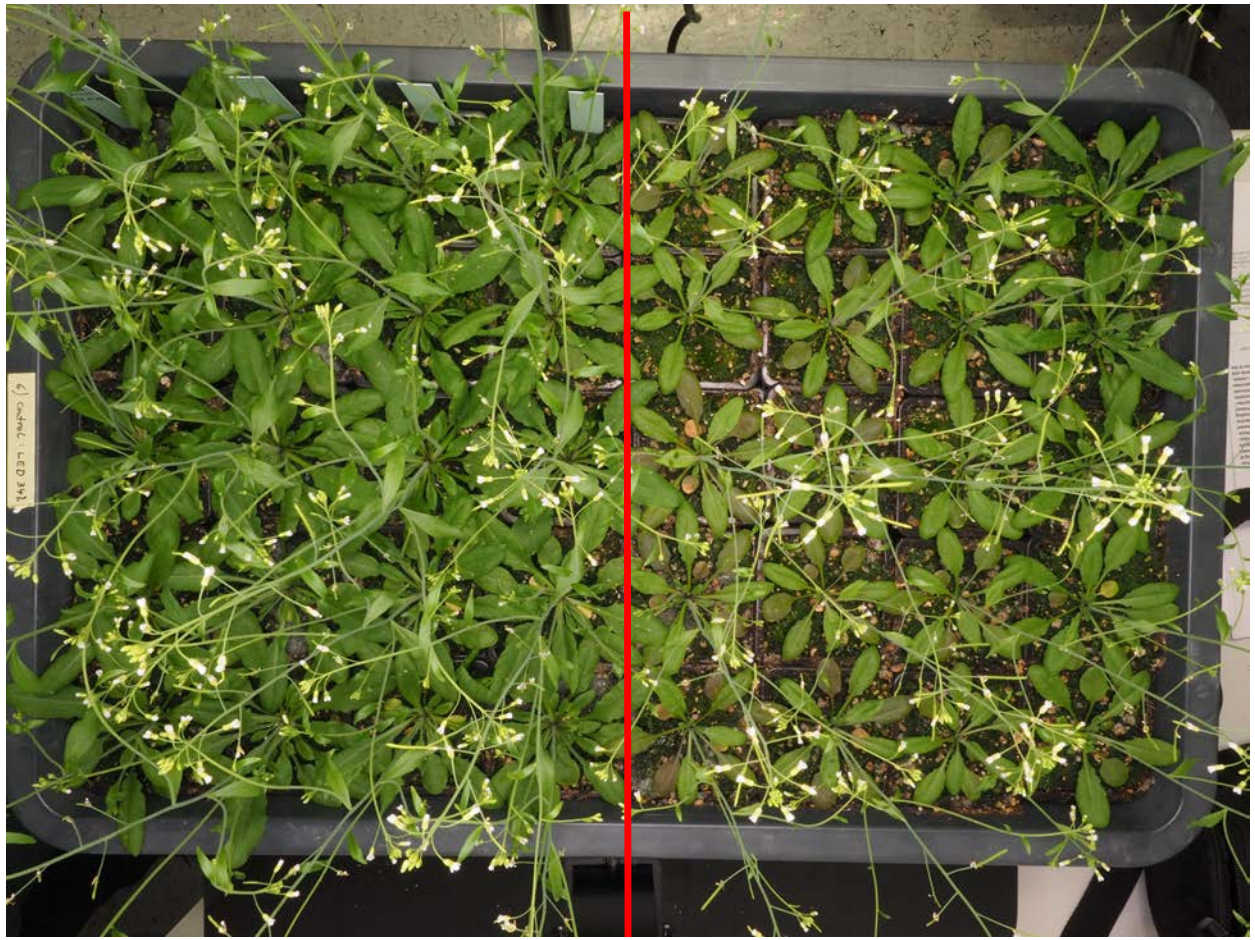
fertilized control

- Spectrum: White LEDs only!

  Other channels cut to 0%.

6. FULL LED SPECTRUM

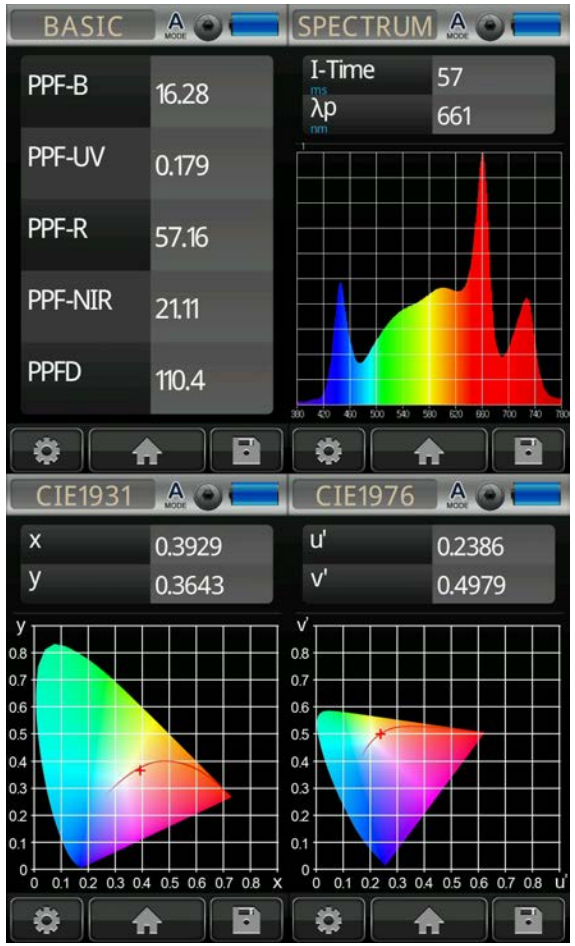


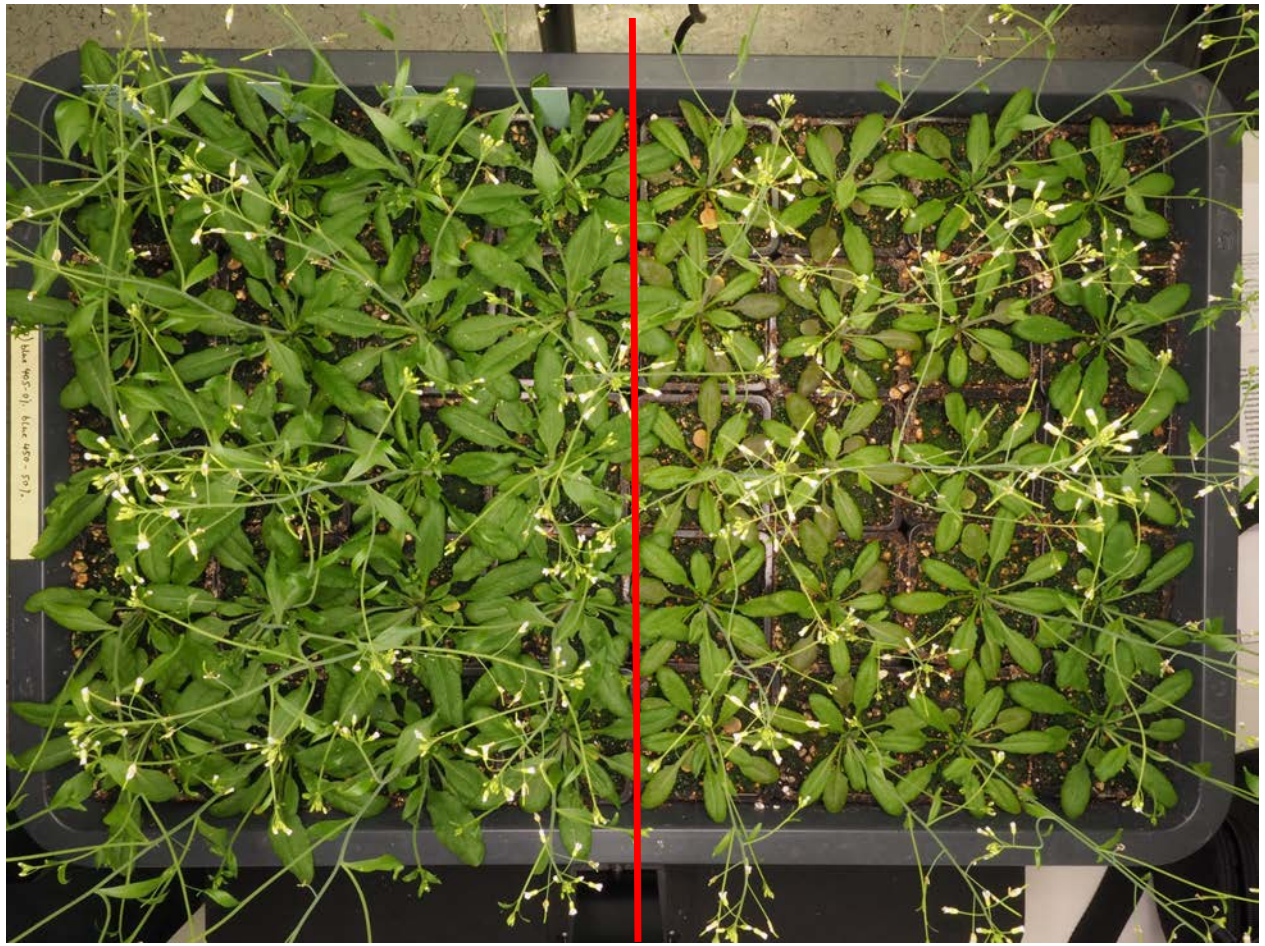


fertilized control

- Spectrum: Full LED spectrum; no modifications!

7. B405 0% & B450 50%

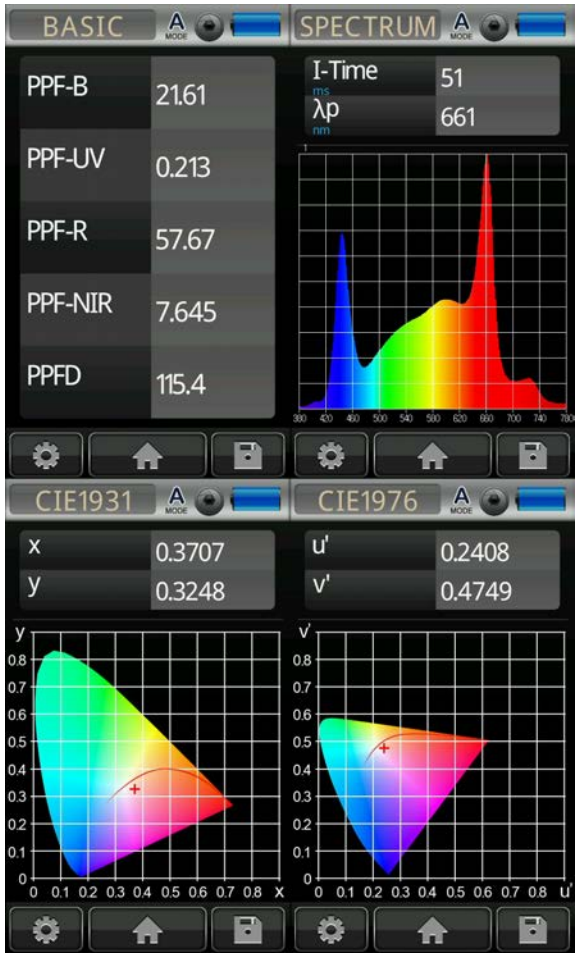


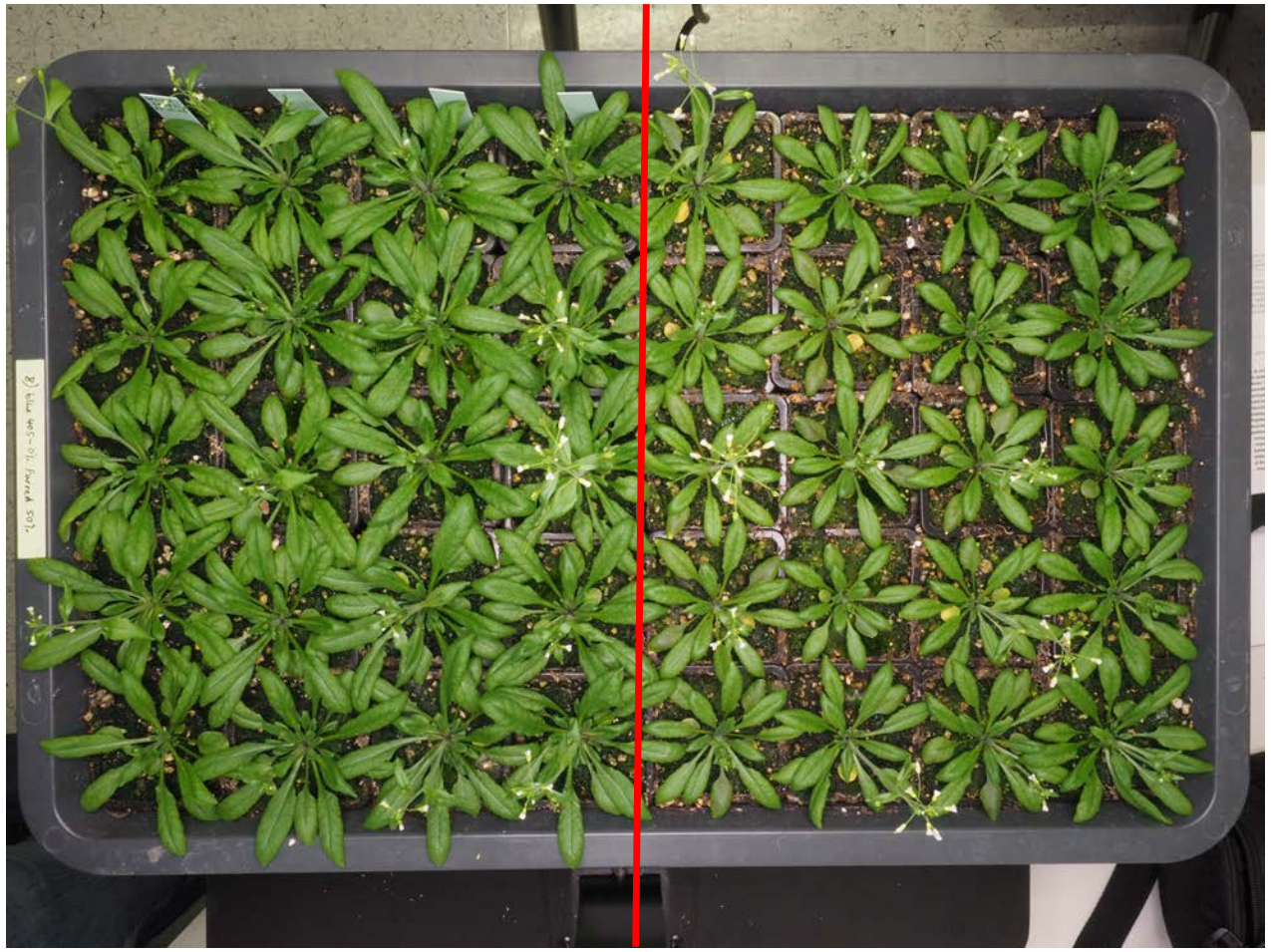


fertilized control

- Spectrum: Blue_405nm cut to 0% & Blue_450nm cut to 50%

8. B405 0% & FR735 50%

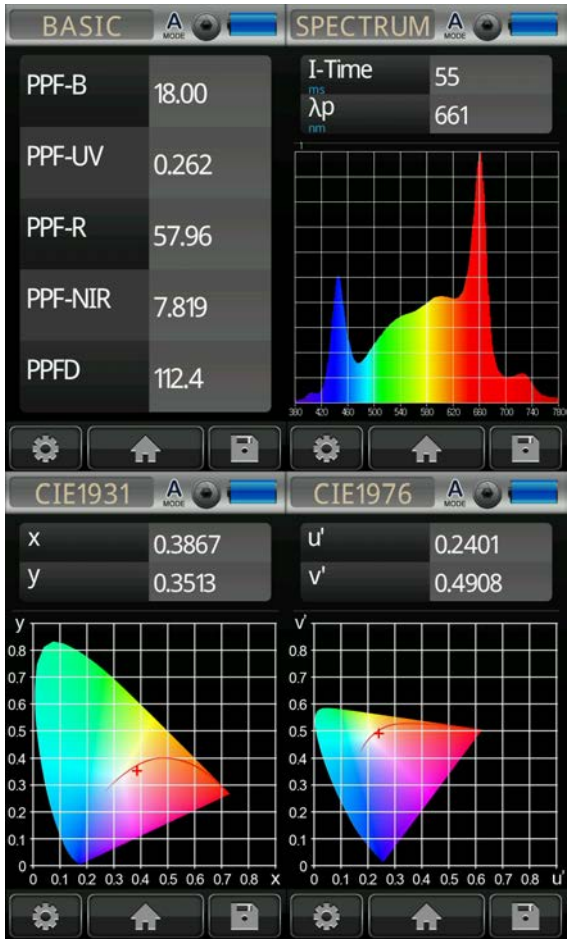




fertilized control

- Spectrum: Blue_405nm cut to 0% and Far-Red_735nm cut to 50%.

9. B405 0%, B450 50% & FR735 50%



fertilized control

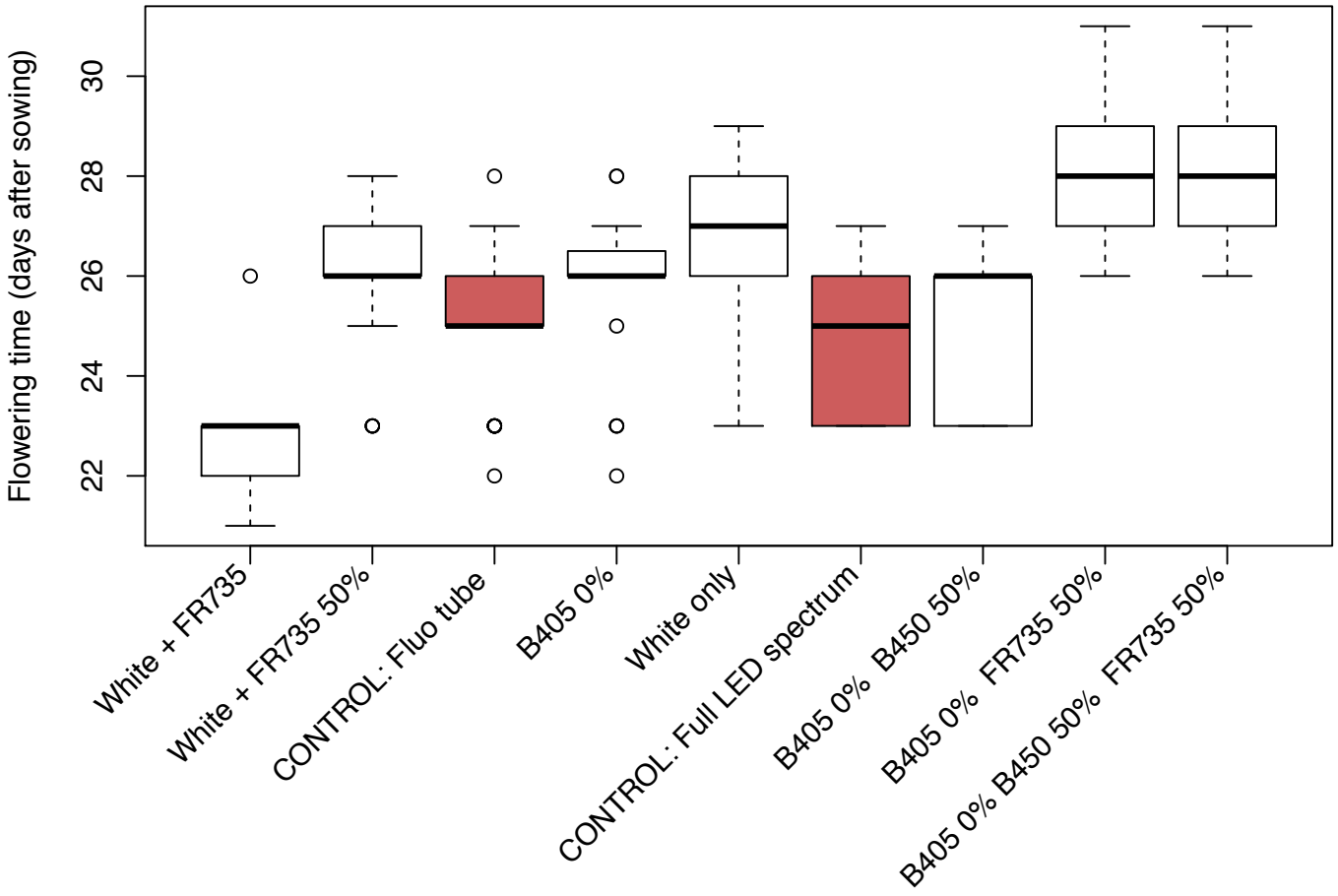
- Spectrum: Blue_405nm cut to 0%; Blue_450nm to 50% and Far-Red_735nm to 50%.

FLUO VS LED FULL

Fluo (3) fertilized | Fluo (3) control | LED full (6) fertilized | LED full (6) control

Fluo (3) fertilized | Fluo (3) control | LED full (6) fertilized | LED full (6) control

FLOWERING TIME



Important:
please note that DAS24 was a Saturday and DAS25 a Sunday and so no flowering time scoring did take place.

CONCLUSION

- Irrespective of the spectral conditions, most of the untreated plants show, to a certain extent, stress symptoms and Anthocyanin accumulation. This applies also to the fluorescent tube control spectrum (!)
- All treated (fertilized) samples look very healthy and do not show any above described symptoms.
- Flowering time scoring data has missing timepoints due to the weekend. No significant difference between Fluo tubes (3) and LED full spectrum (6). Light condition 1 flowers significantly earlier; condition 8 and 9 later.
- Hypothesis: Light stress caused by a (local) Phosphor (or other) nutrient deficiency (see also literature next slide)
- Factors to be considered:
  - Gramoflor_2006 less fertilized then ED63 (old type of soil)
  - Slow P diffusion rates in soil (forming of depletion zones at the root surface)
  - Active P transport (multiple transporters)
  - P transport and root activity inhibiting factors: low temperatures (cold water watering) and excess of water (flooding system)
  - Washing out of nutrients by the automated flooding system (?)
  - Sieving out of P binding particles (?)

LITERATURE

- "Main environmental inducers of anthocyanin synthesis: low temperature (Strand et al., 1997), nutrient deficiency (Paul & Stitt, 1993), wounding and pathogen infection (Balachandran et al., 1997), flooding (Topa & Cheeseman, 1992) and oxidative stress (Foot et al., 1996)."
- "Anthocyanin accumulation is a distinctive symptom of P deficiency in many plants, though N deficiency may also induce purpling (Cobbina & Miller, 1987; Nozzolillo et al., 1990; Close et al., 2000)"
- "Low P levels and P distribution mechanisms lead to an imbalance among the ability of plants to process light energy and the light income, which in turn may cause photo-oxidative stress." [3]
- "Phosphorus deficiency tends to inhibit or prevent shoot growth. Leaves turn dark, dull, blue-green, and may become pale in severe deficiency. Reddish, reddish-violet, or violet color develops from increased anthocyanin synthesis. Symptoms appear first on older parts of the plant. New leaves usually appear healthy, but they are often small. Phosphorus deficiency also leads to increased root to shoot ratio in many plant species." https://plantscience.psu.edu/research/labs/roots/methods/methods-info/nutritional-disorders-displayed

[1] **Anthocyanidins and anthocyanins: colored pigments as food, pharmaceutical ingredients, and the potential health benefits**. Khoo HE, Azlan A, Tang ST, Lim SM. Food Nutr Res. 2017 Aug 13;61(1):1361779. doi: 10.1080/16546628.2017.1361779. eCollection 2017.

[2] **Anthocyanins in vegetative tissues: a proposed unified function in photoprotection**. W. J. Steyn, S. J. E. Wand, D. M. Holcroft and G. Jacobs, New Phytologist 2002 Aug 20;155(3) 349-361, https://doi.org/10.1046/j.1469-8137.2002.00482.x

[3] **Linking phosphorus availability with photo-oxidative stress in plants**. Hernandez I, Munne-Bosch S. J Exp Bot. 2015, Vol.66,No. 10pp 2889-2900, doi: 10.1093/jxb/erv056

NEXT STEPS

- Quick test of soil (ongoing): Gramoflor_2006, ED63 and Neuhaus N3. Also incl. vermiculite.
- Deeper investigation and analysis of the present and future soil composition and chemistry
- Test of a very promising soil type candidate used at the ETH Zürich, IPK and PSI (phenotyping company) “Klasmann Substrat 2”

https://www.klasmann-deilmann.com/redirects/pdf-files/downloads/klasmann_easy_growing_2013_german.pdf

- We will keep you posted and appreciate your feedback!

THANK YOU !

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