

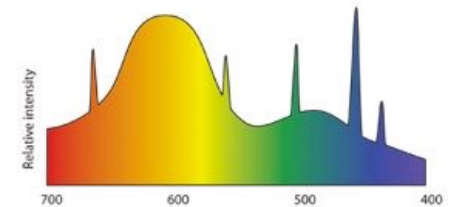
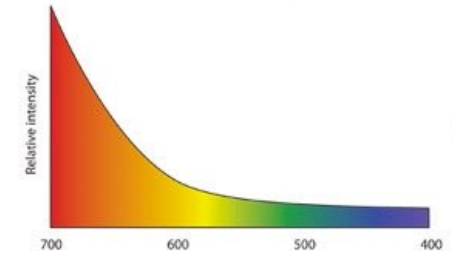
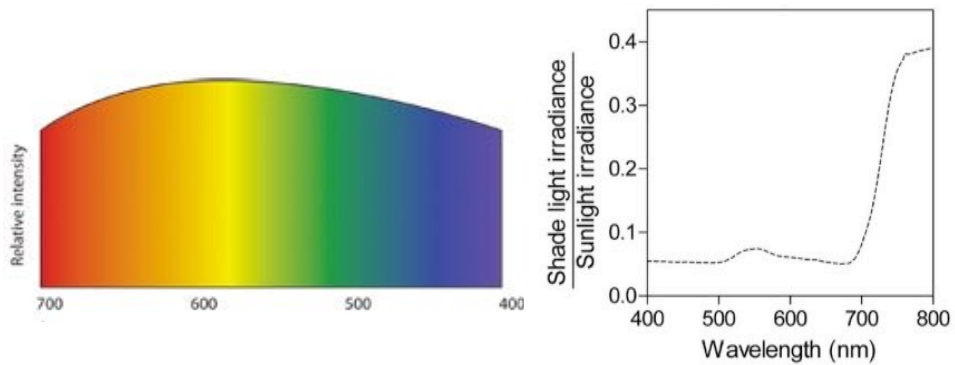
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# IMPROVING YIELD IN VERTICAL FARMING: INSIGHTS FROM PLANT PHOTOBIOLOGY

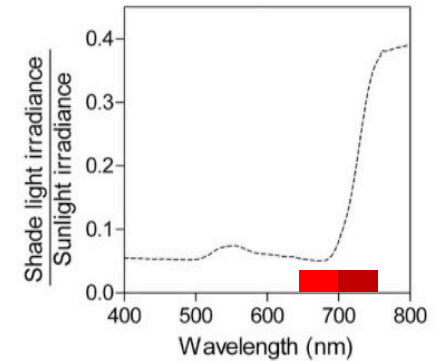
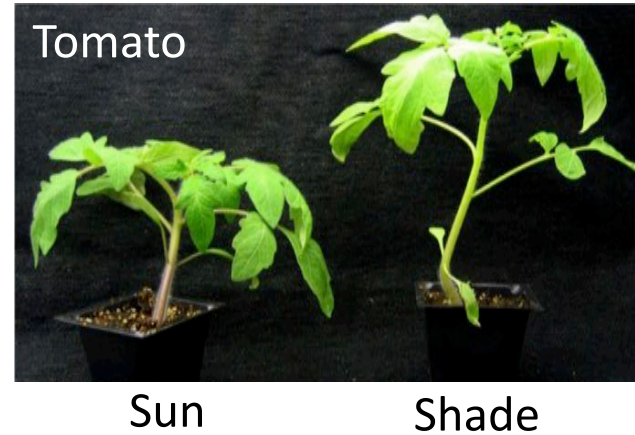
# Light is a regular, yet dynamic signal



# Different light sources have distinct colours



# Plants are acutely sensitive to light



- Quantity
- Colour
- Timing and direction



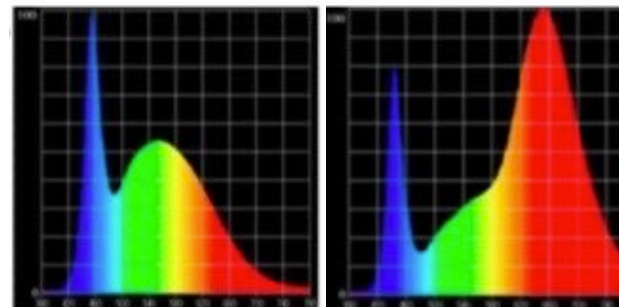
# Manipulating light can be beneficial for growth

Plant	Light intensity	Biomass g/plant T0	Biomass g/plant T1
Roman lettuce	Low	4,52	5,53
	High	5,20	10,43
Butterhead lettuce	Low	7,62	9,42
	High	17,92	19,07
Tomato	Low	4,24	4,71
	High	8,61	14,41
Pepper	Low	5,69	7,86
	High	11,72	12,87



T0

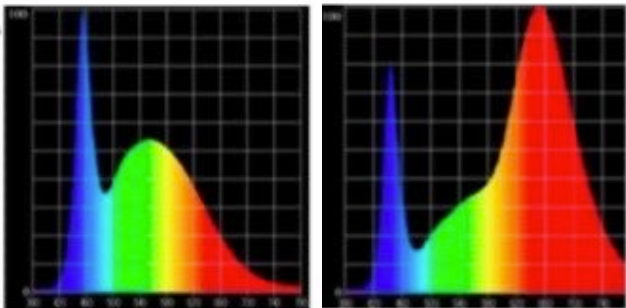
T1



# Plant development is controlled by light



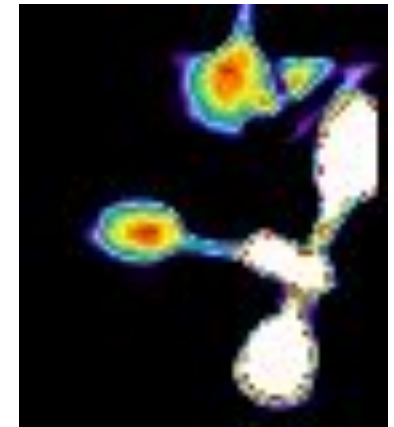
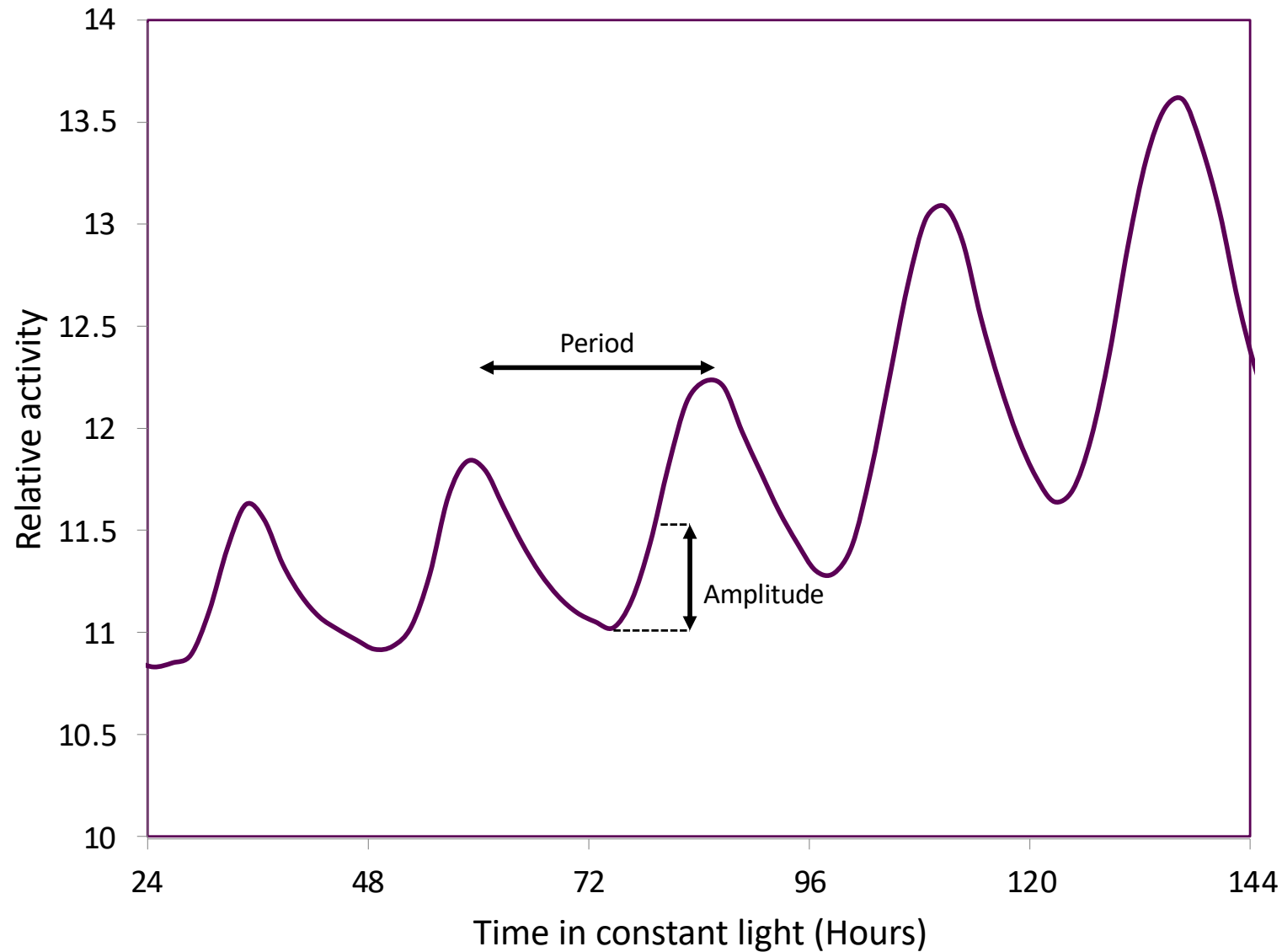
- Germination
- Shade avoidance
- Vegetative growth
- Secondary metabolism
  - Flavours, textures
- Flowering time
  
- These responses vary by crop (and by commercial trait)





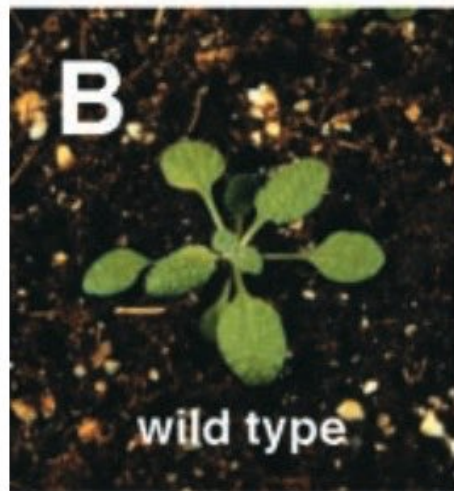
**PLANTS MEASURE DAYLENGTH  
USING A BIOLOGICAL CLOCK**

# Circadian rhythms change plant behaviour





# Circadian clocks are conserved amongst plants



Wildtype



*elf3*

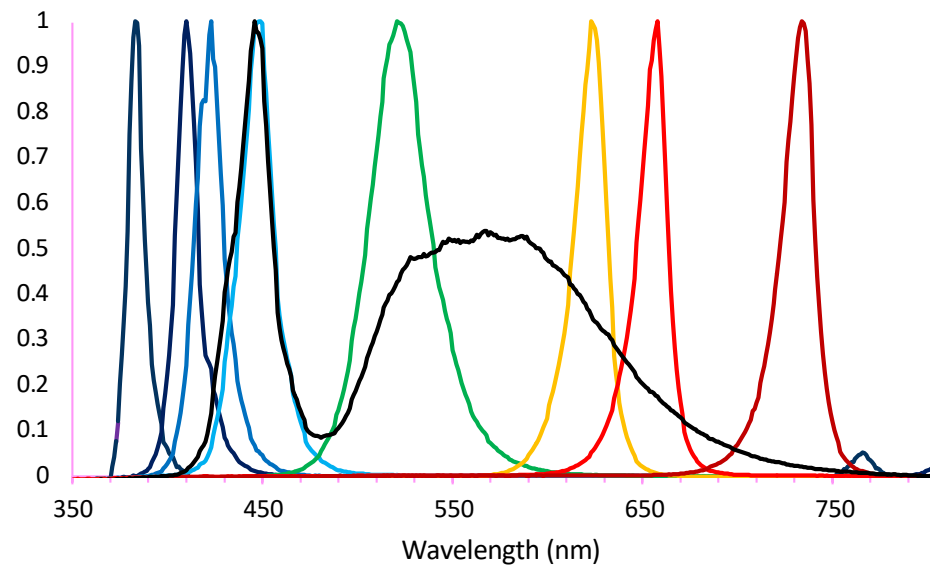
# Understanding plants' responses to light

- Environmental conditions vary on daily and seasonal timescales
- Plants are developmentally plastic, and are highly responsive to light (and temperature) signals
- Circadian rhythms provide a context of time

# Vertical farming will boost urban agriculture

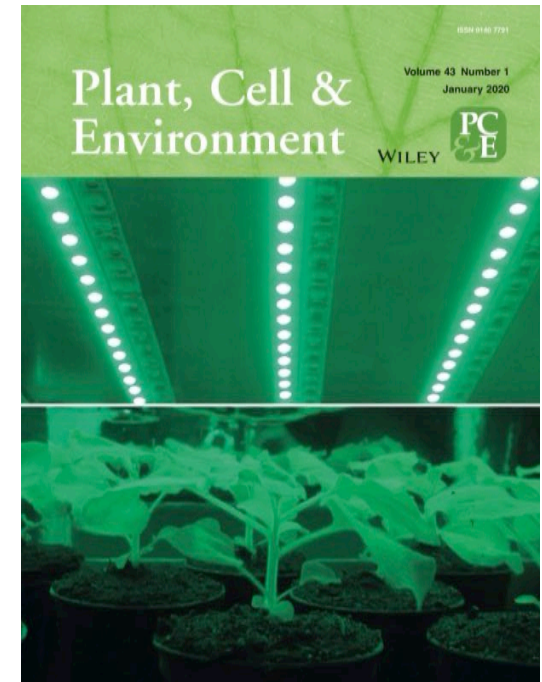
- Self-contained growing modules with LEDs and air conditioning systems
- Utilization of LEDs is efficient but brings its own complications

# LEDs allow us to precisely control the growth environment



# Applying Photobiology

- 1) Re-designing crops- Selective breeding for vertical farms
- 2) Green means go?

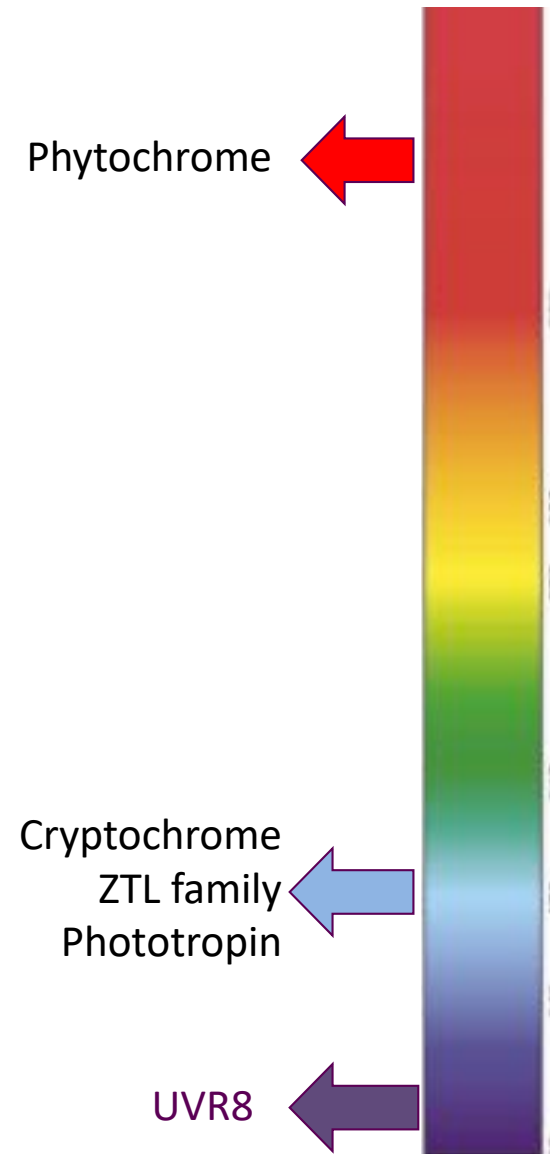


# 1) RE-DESIGNING CROPS- SELECTIVE BREEDING FOR VERTICAL FARMS

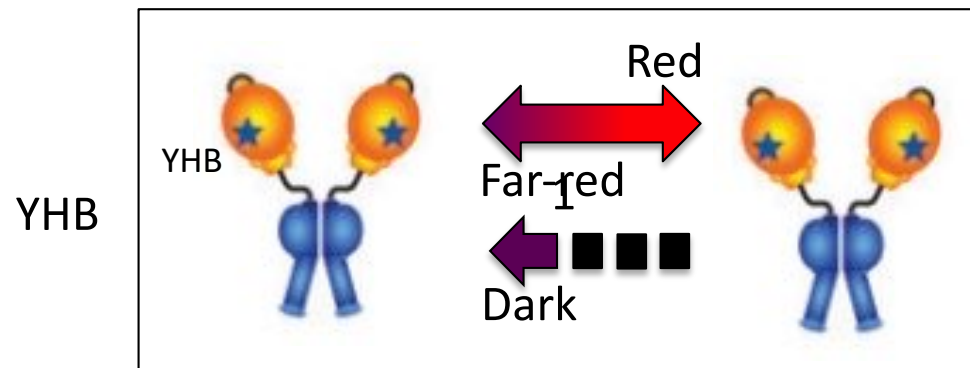
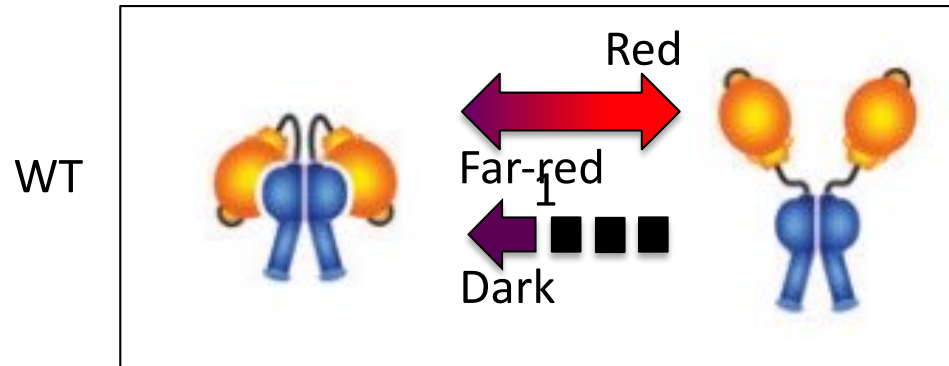


# Plants perceive light via distinct signalling pathways

- Photoreceptors found in each cell absorb and respond to light
- These are specific to different colours

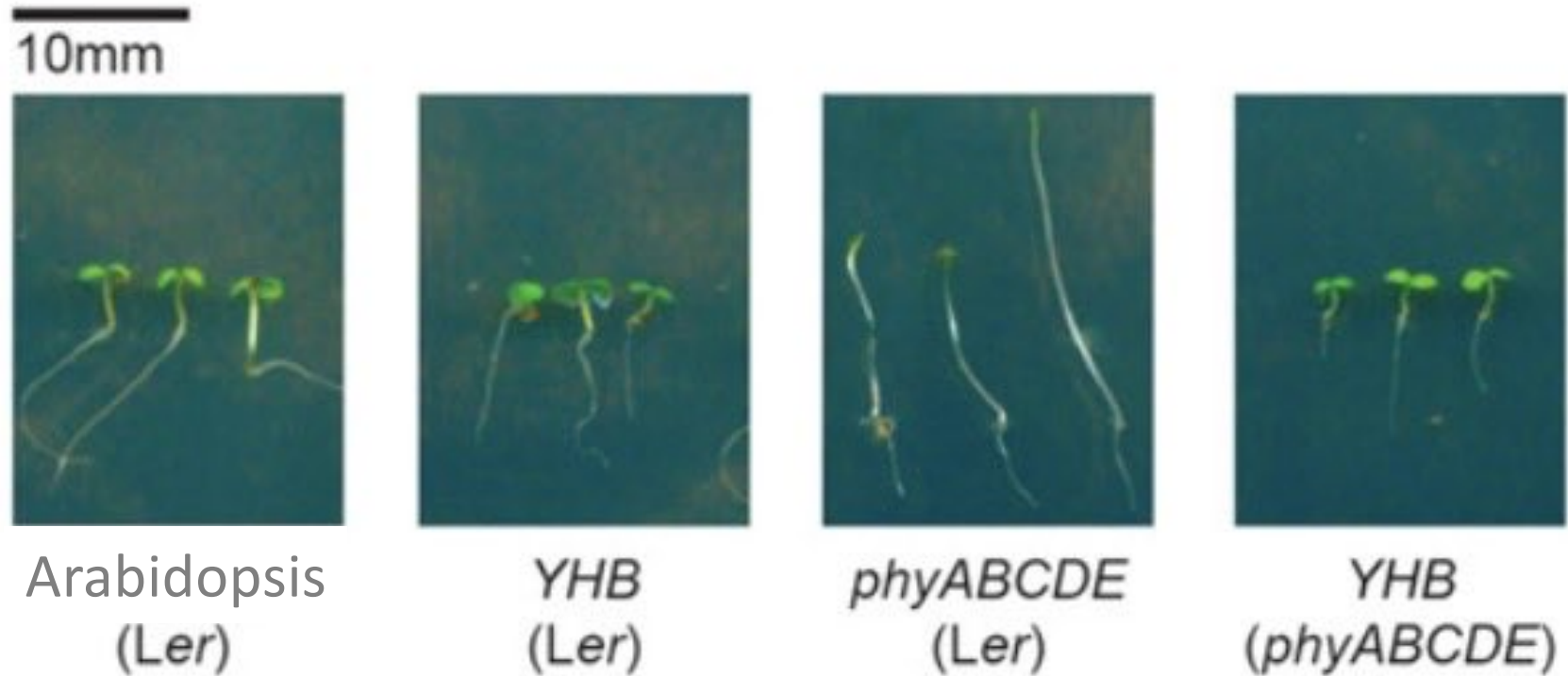


# Phytochrome can be manipulated into a constitutively-active state





# Photoreceptor engineering enables plant behavior to be manipulated



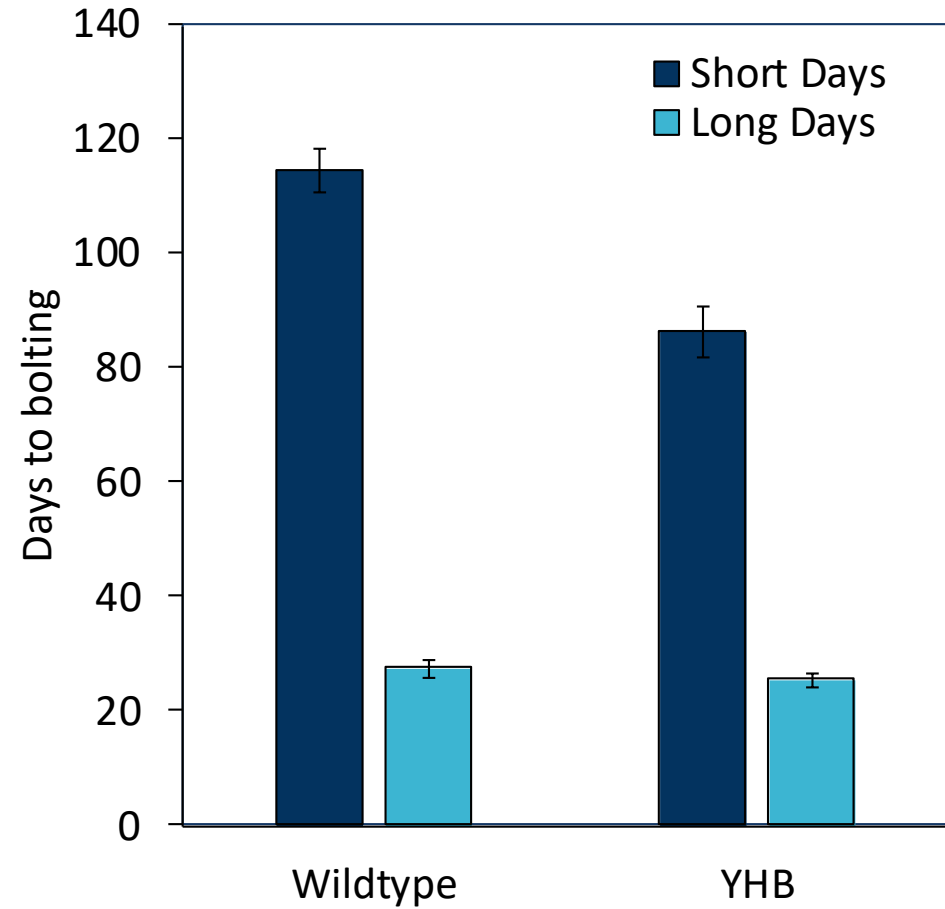
# YHB plants are more compact and flower earlier

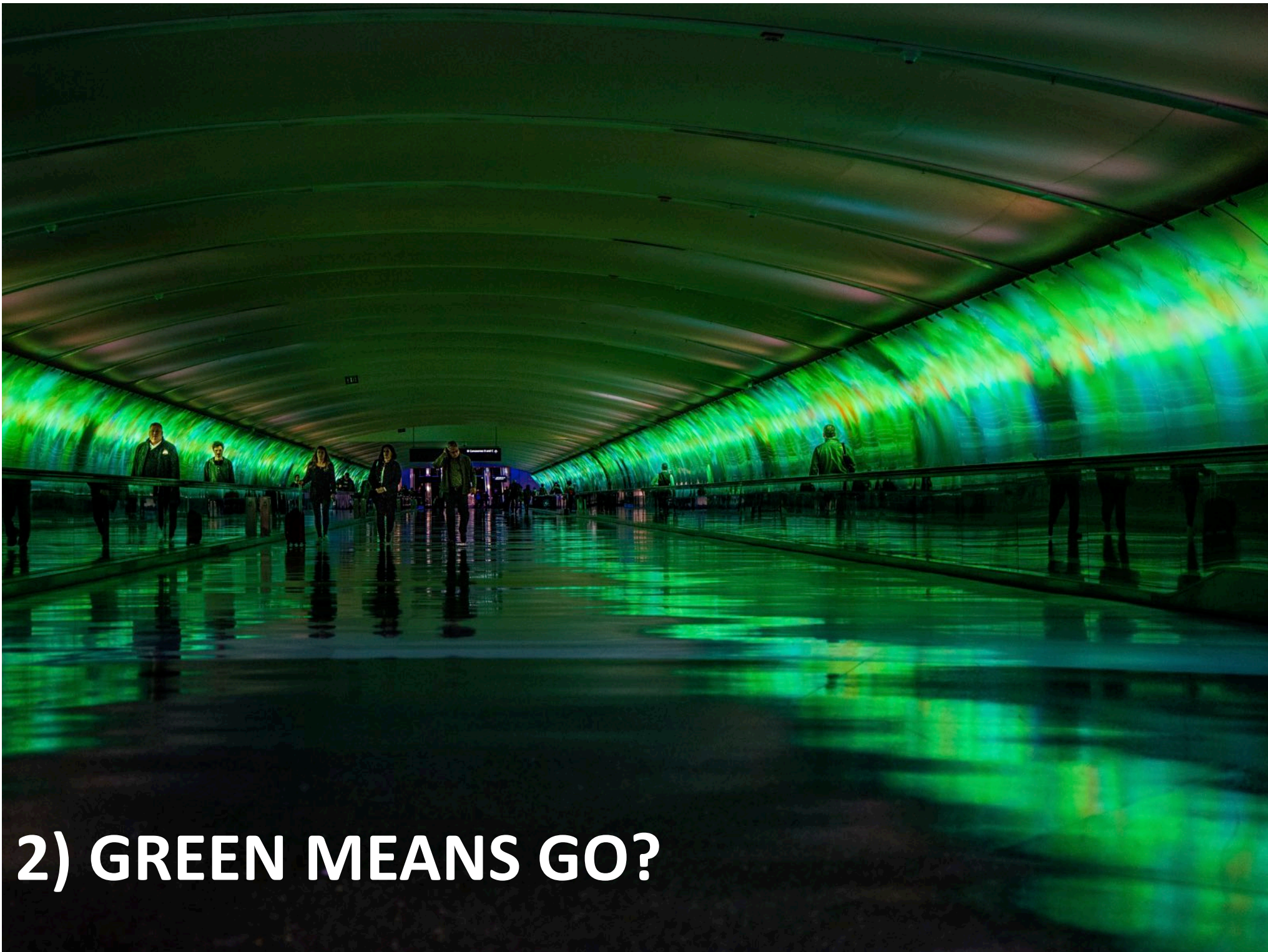


WT



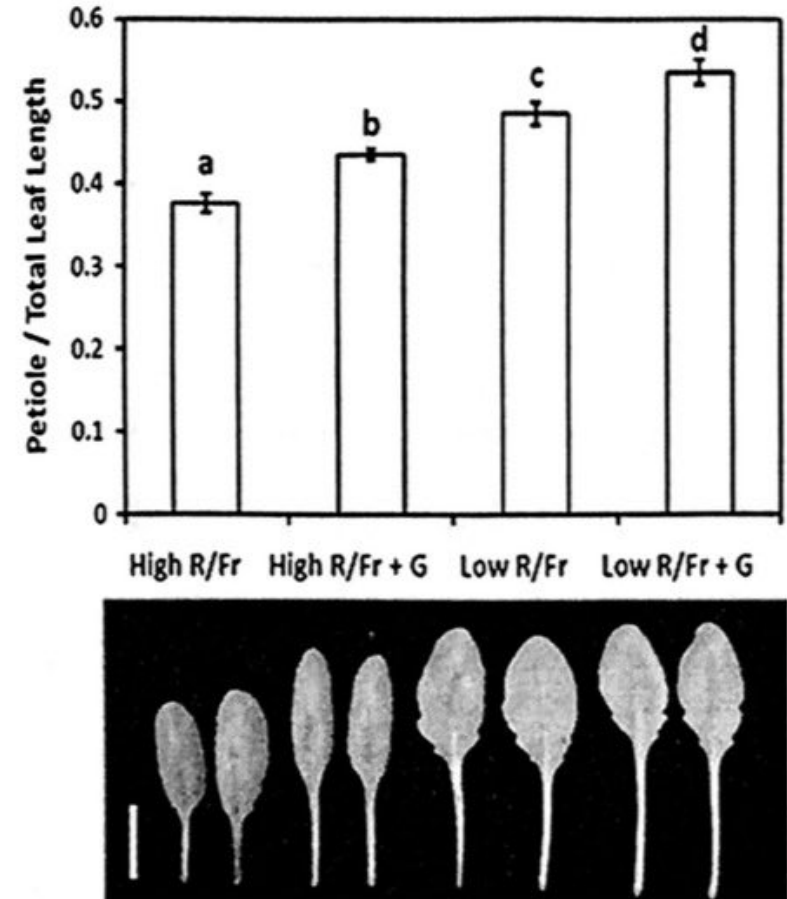
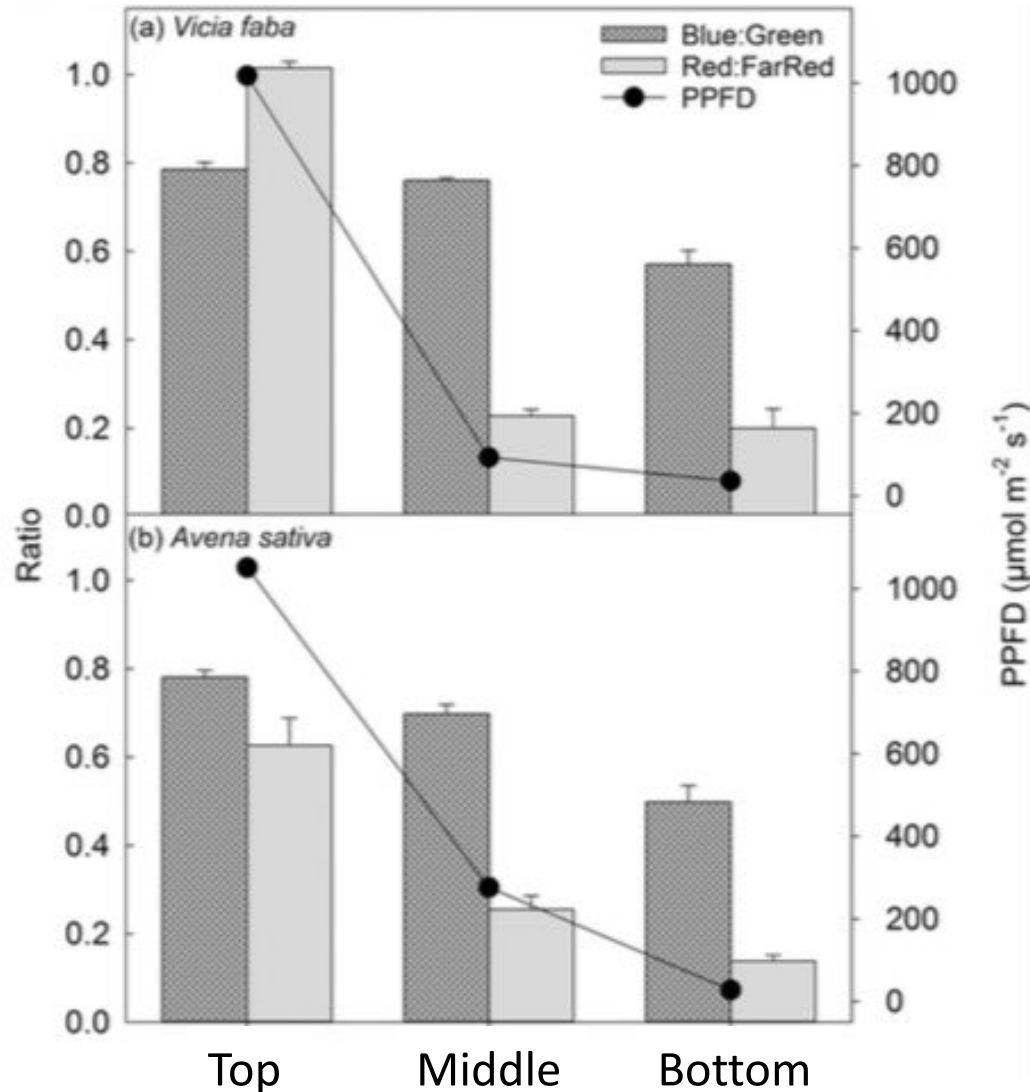
YHB



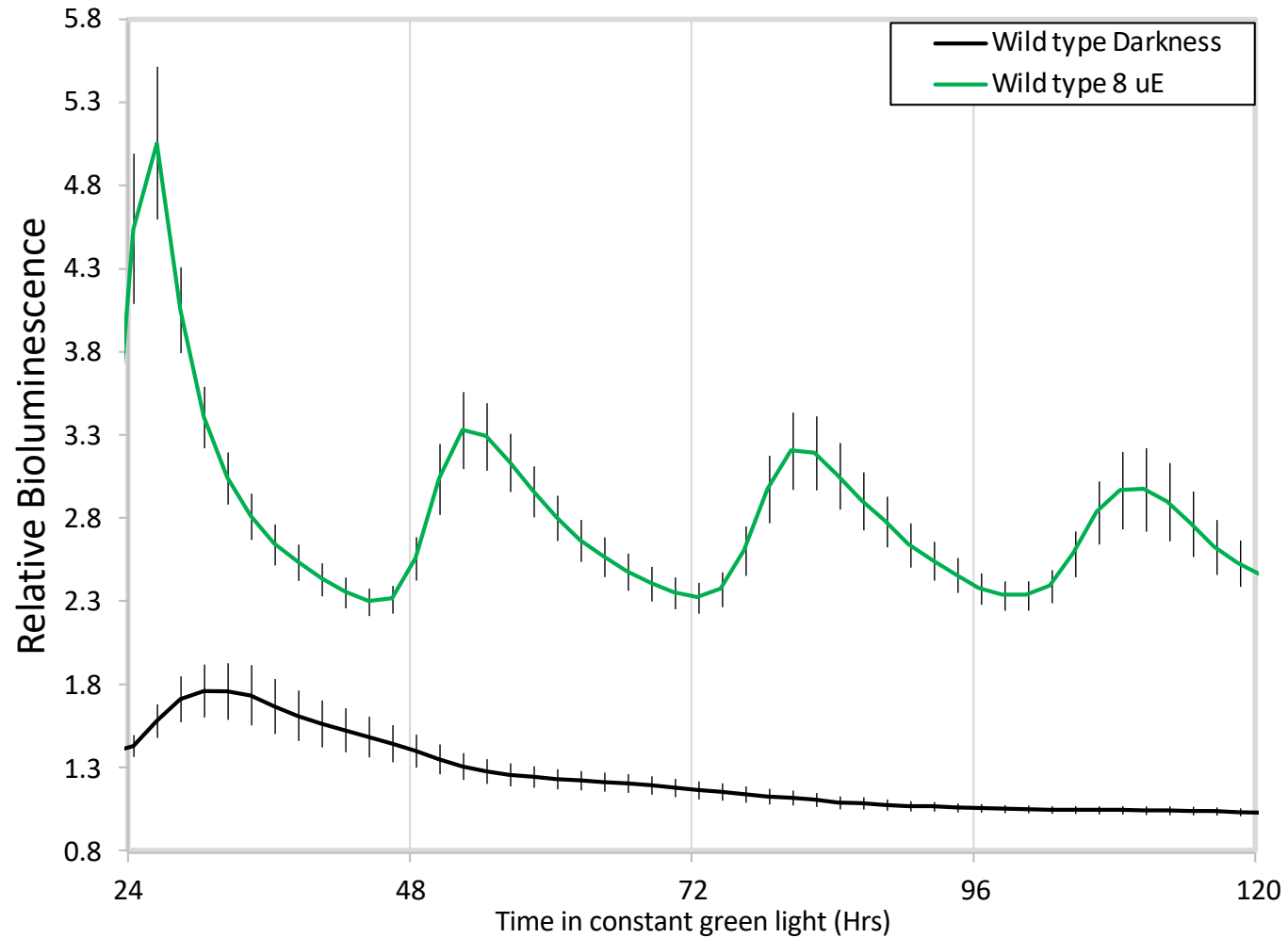


## 2) GREEN MEANS GO?

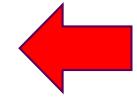
# Green light is an indicator of shade



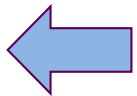
# Green light maintains circadian rhythms



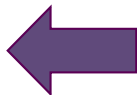
Phytochrome



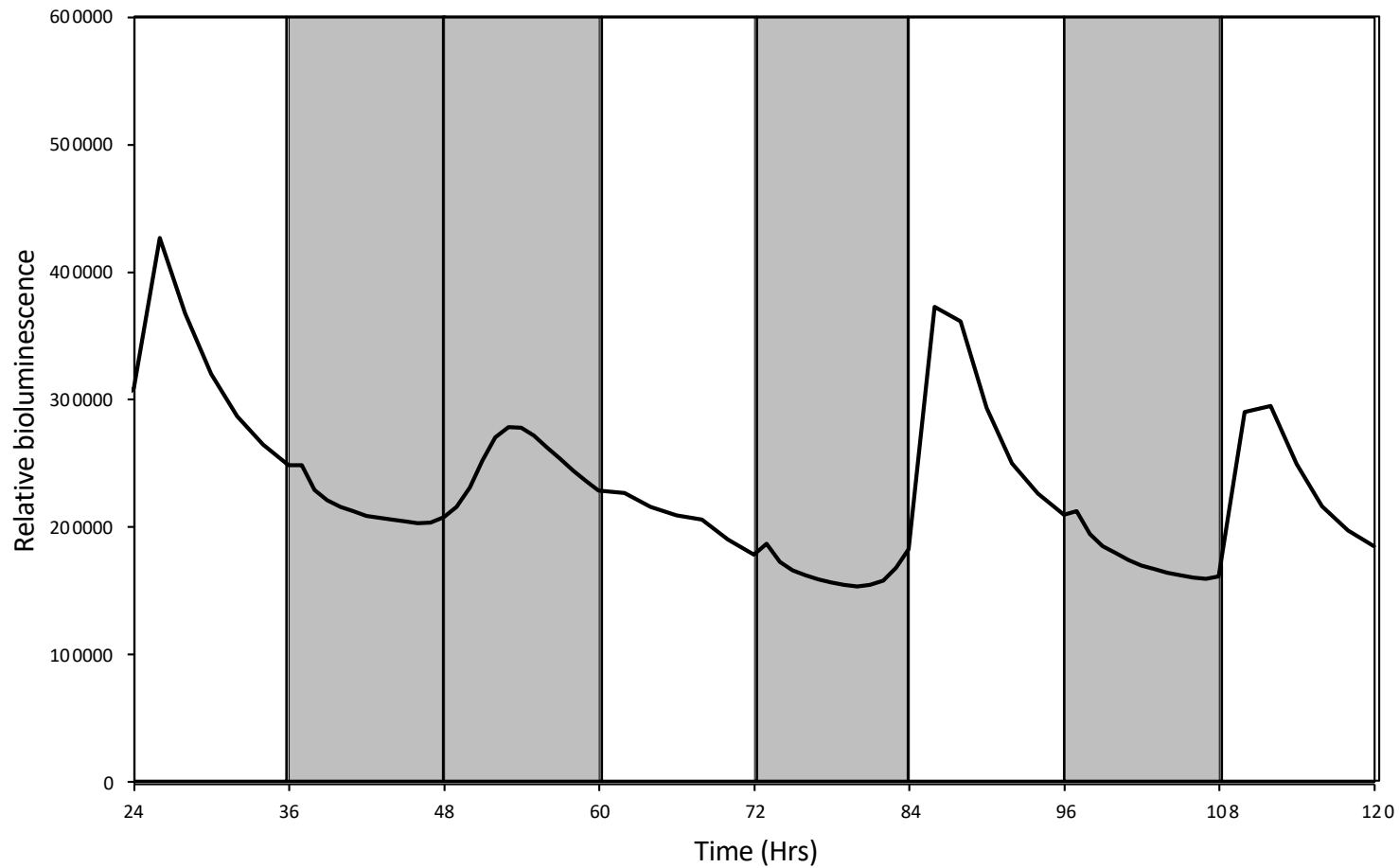
Cryptochrome  
ZTL family  
Phototropin



UVR8



# The clock is reset by green light



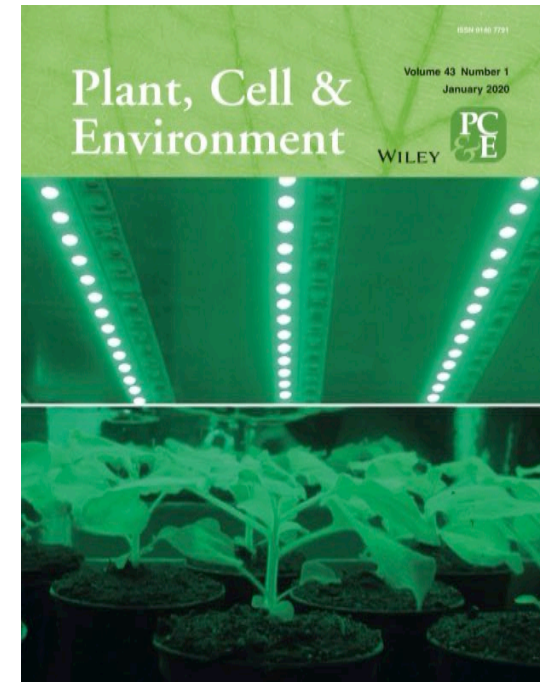
# Applying Photobiology

## 1) Re-designing crops- selective breeding for vertical farms

- Photoreceptors are excellent targets to manipulate plant growth

## 2) Green means go?

- Green light is an additional indicator of shade that also regulates circadian timing



# Thanks!

- Dr Mhairi Davidson
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- Dr Putri Prasetyaningrum
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- Dr Jim Stevens
- Dr Emily Armstrong
- Marina Viana Quieroz



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