



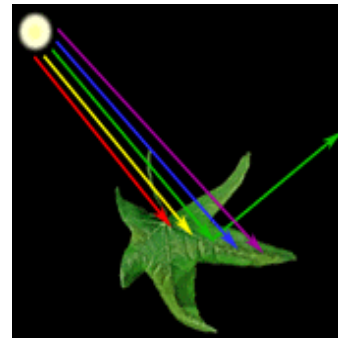
# Piante e colori dello spettro: fiat lux!

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rparadis@unina.it

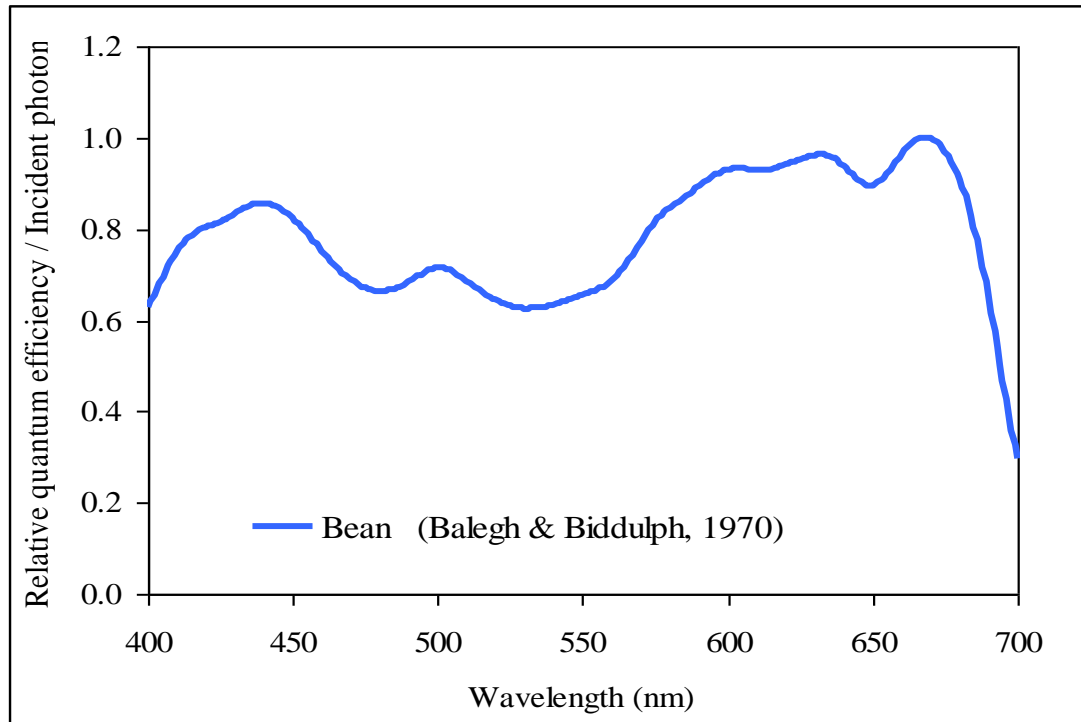


# Qualità della luce e Fotosintesi



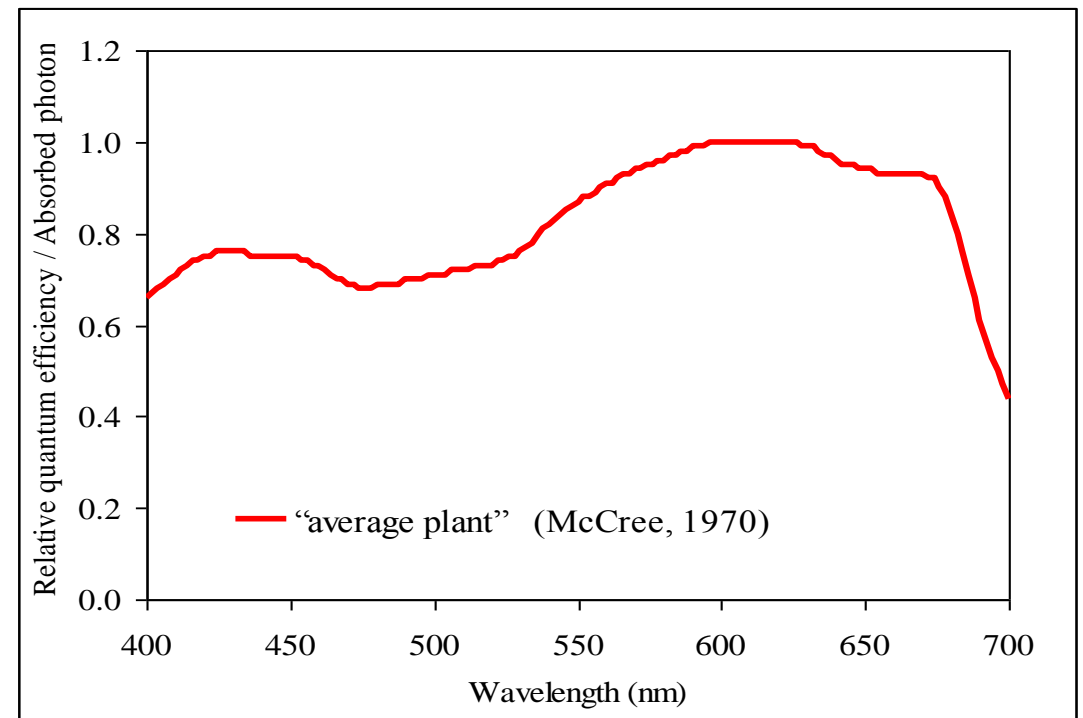
## Spettro d'Azione

( $\mu\text{mol}$  di  $\text{CO}_2$  per  $\mu\text{mol}$  di luce incidente)

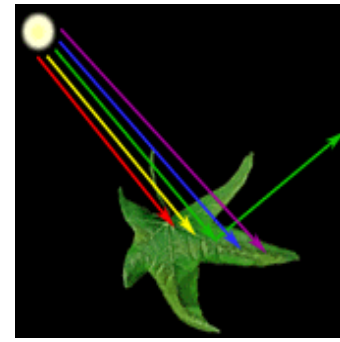



## Resa Quantica Spettrale

( $\mu\text{mol}$  di  $\text{CO}_2$  per  $\mu\text{mol}$  di luce assorbita)

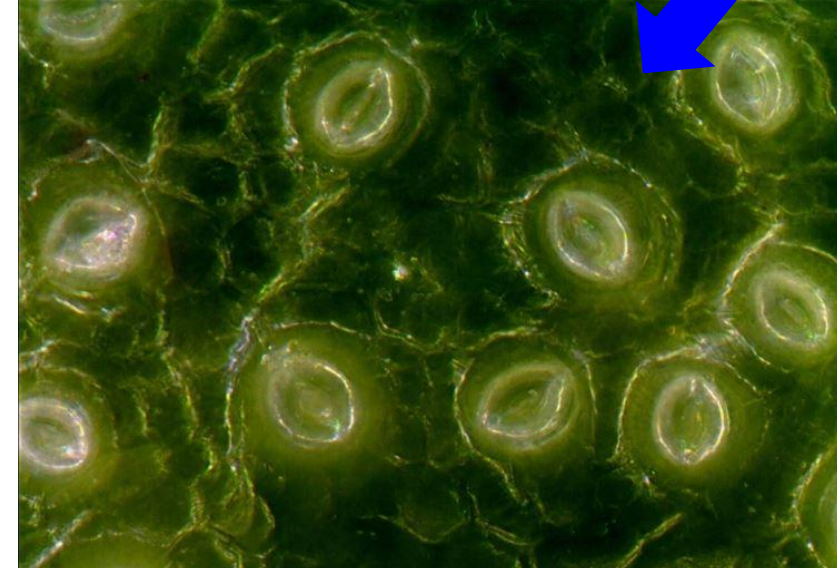
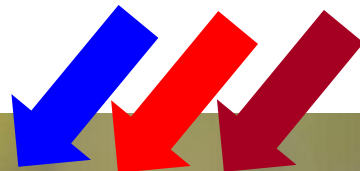


# Qualità della luce e Fotomorfogenesi



Wavelengths	Photoreceptors	Plant response
 <p>Red, Far-red (600-750 nm)</p>	<b>PHYs</b>	Germination, De-etiolation, Shade avoidance, Inhibition of stem and petiole elongation, Leaf expansion and flattening, Circadian rhythms, Flowering, Branching
<p>Green (530- 570 nm)</p>		
<p>Blue (450-500 nm)</p>	<b>CRYs</b>	De-etiolation, Inhibition of stem and petiole elongation, Leaf expansion, Circadian rhythms, Flowering, Flavonoid biosynthesis. Response to shade by B/G photoperception
<p>UV-A (320-390 nm)</p>	<b>PHOTs</b>	Leaf flattening, Phototropism, Stomatal opening, Chloroplast relocation
<p>UV-B (290-315 nm)</p>		
	<b>ZTL/FKF1/LKP2</b>	Circadian rhythms, Flowering
	<b>UVR8</b>	De-etiolation, Flavonoid biosynthesis







# Illuminazione artificiale in orto-floricoltura

- Assimilativa
- Fotoperiodica
- Sostitutiva
- Aumento delle rese
- Controllo dell'epoca di produzione
- Miglioramento della qualità



# Illuminazione artificiale in orto-floricoltura

## Molti aspetti

- intensità
- composizione spettrale
- fotoperiodo
- efficienza energetica
- geometria degli impianti

## Molti processi influenzati/controllati

- fotosintesi, accrescimento, sviluppo
- composizione dei tessuti (qualità degli ortaggi)
- composti benefici
- sensibilità alle patologie





# Antirrhinum majus L.

## Flower induction



Juvenility

Inflorescence development



### RESPONSE GROUPS (cold greenhouse)

- I - winter - early spring  
night temperatures 7-10°C; SD - low light intensity
- II - late winter - spring  
night temperatures 10-13°C ; SD - low light intensity
- III - late spring - autumn  
night temperatures 13-16°C; LD - high light intensity
- IV - summer  
higher than 16°C; LD - high light intensity

Critical size = 300 cm<sup>2</sup>/plant leaf area



# *Lisianthus russellianus* Hook

(syn. *Eustoma grandiflorum* Griseb.)

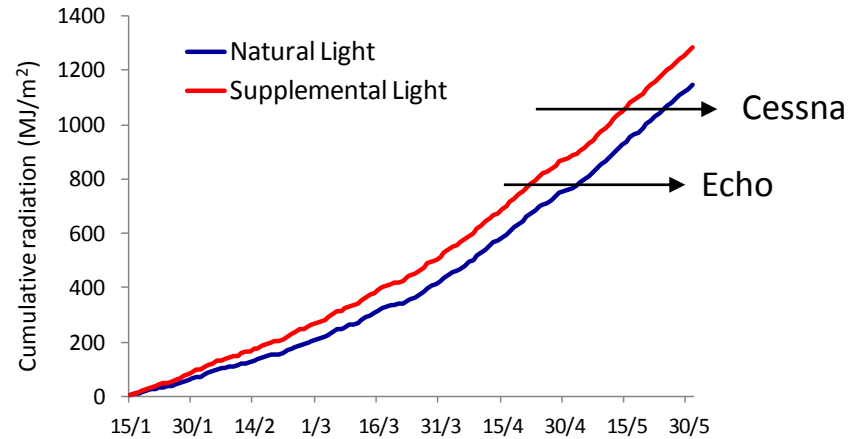
## RESPONSE GROUPS

(heated greenhouse in mild winter climate)

I - late autumn-winter (from the end of October to the middle of February)

II - early spring (from the end of February to the end of June)

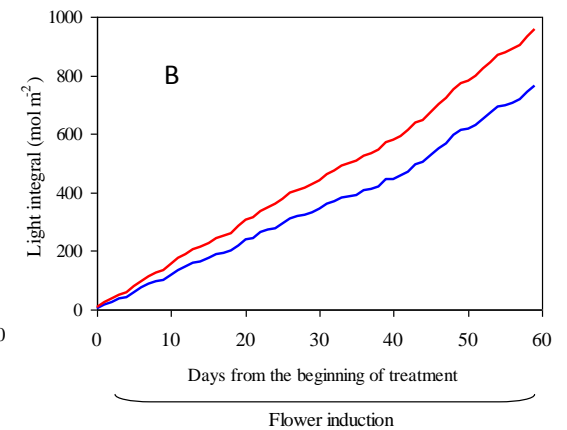
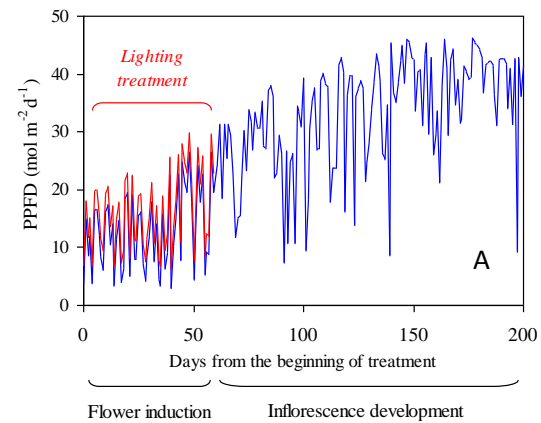
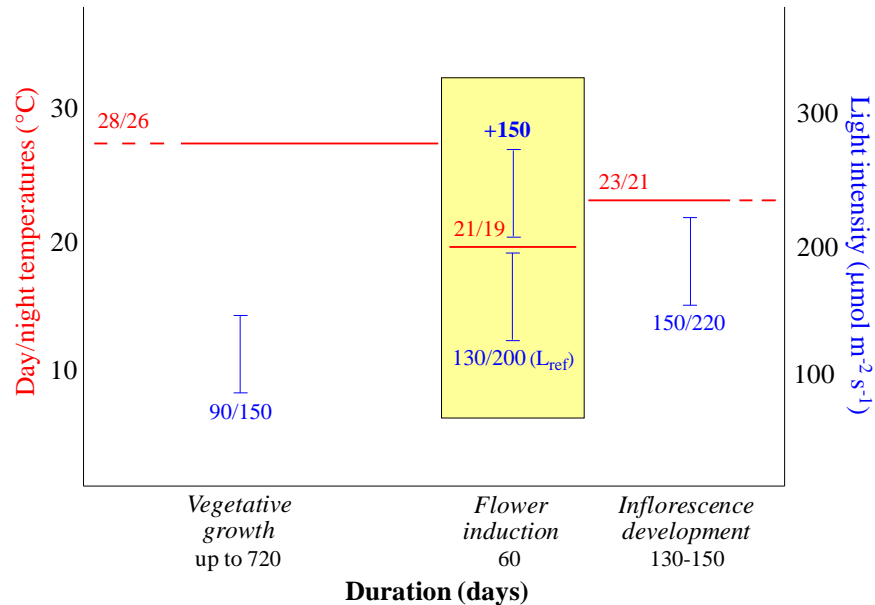
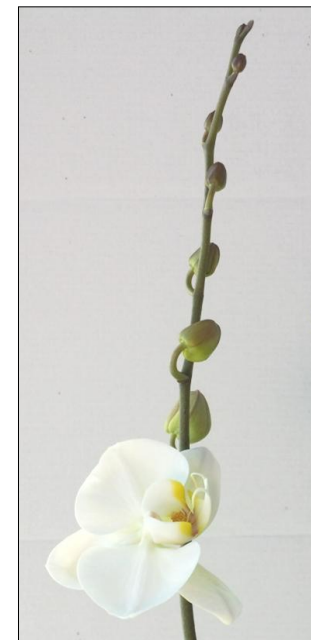
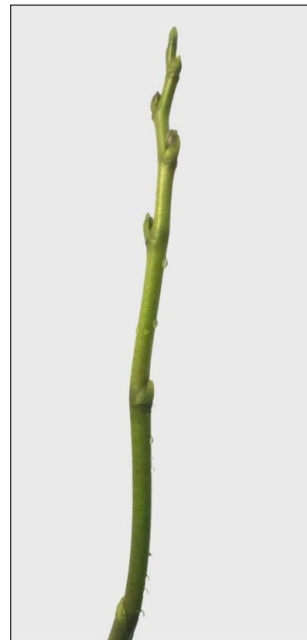
III - late spring-summer (from the middle of April to the end of June)



	Time for flowering (days)	Light integrals at flowering (MJ/m²)	Daily light integrals (MJ/m²)
Echo	103	784	7.6
Cessna	126	1069	8.5



# Phalaenopsis



- Paradiso R., A. Maggio, De Pascale S., 2012. Moderate variations of day/night temperatures affect flower induction and inflorescence development in *Phalaenopsis*. *Scientia Horticulturae*, 139: 102-107.
- Paradiso R., De Pascale S., 2014. Effects of plant size, temperature, and light intensity on flowering of *Phalaenopsis* Hybrids in Mediterranean Greenhouses. *The Scientific World Journal*, Vol. 2014, Art. 420807.



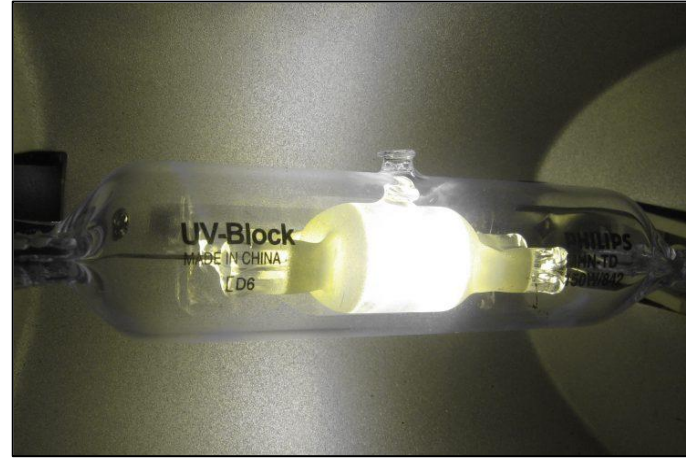


# Illuminazione artificiale e sorgenti luminose

*High-Pressure Sodium  
(HPS)*



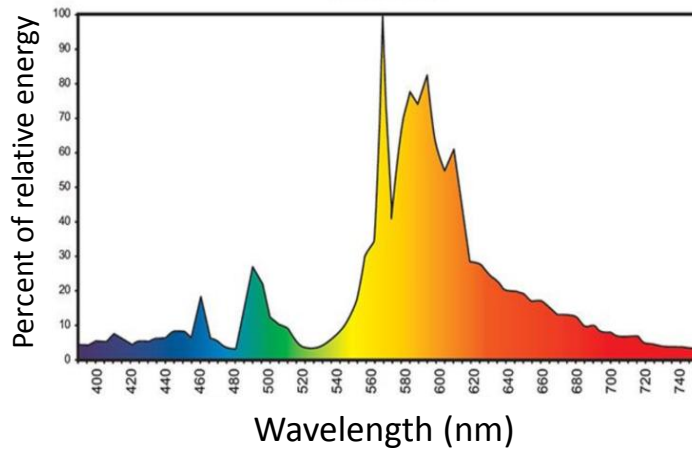
*Metal-Halide  
(MH)*



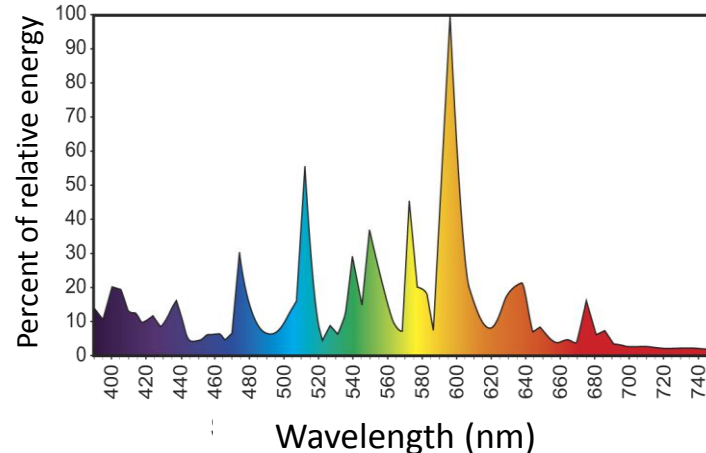
*Light Emitting Diode  
(LED)*



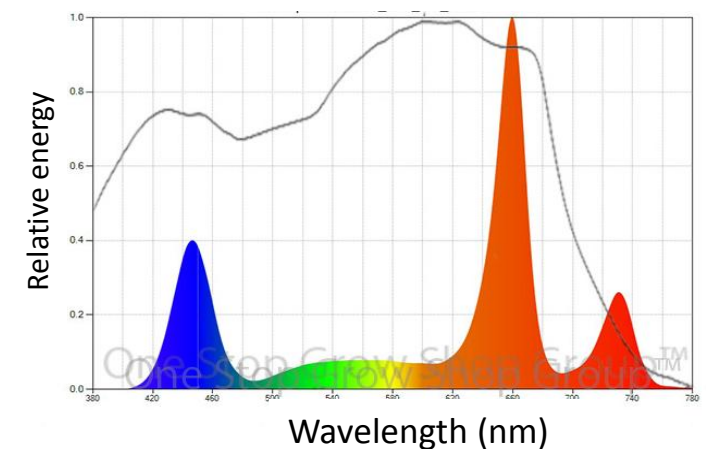
*Eye Hortilux Super HPS  
<https://eyhortilux.com/grow-lights/super-hps/>*



*Eye Hortilux MH  
<https://eyhortilux.com/grow-lights/standard-metal-halide/>*



*Heliospec LX601C  
<https://www.heliospectra.com/>*



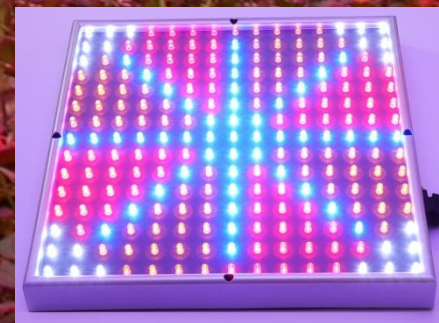


# illuminazione assimilativa

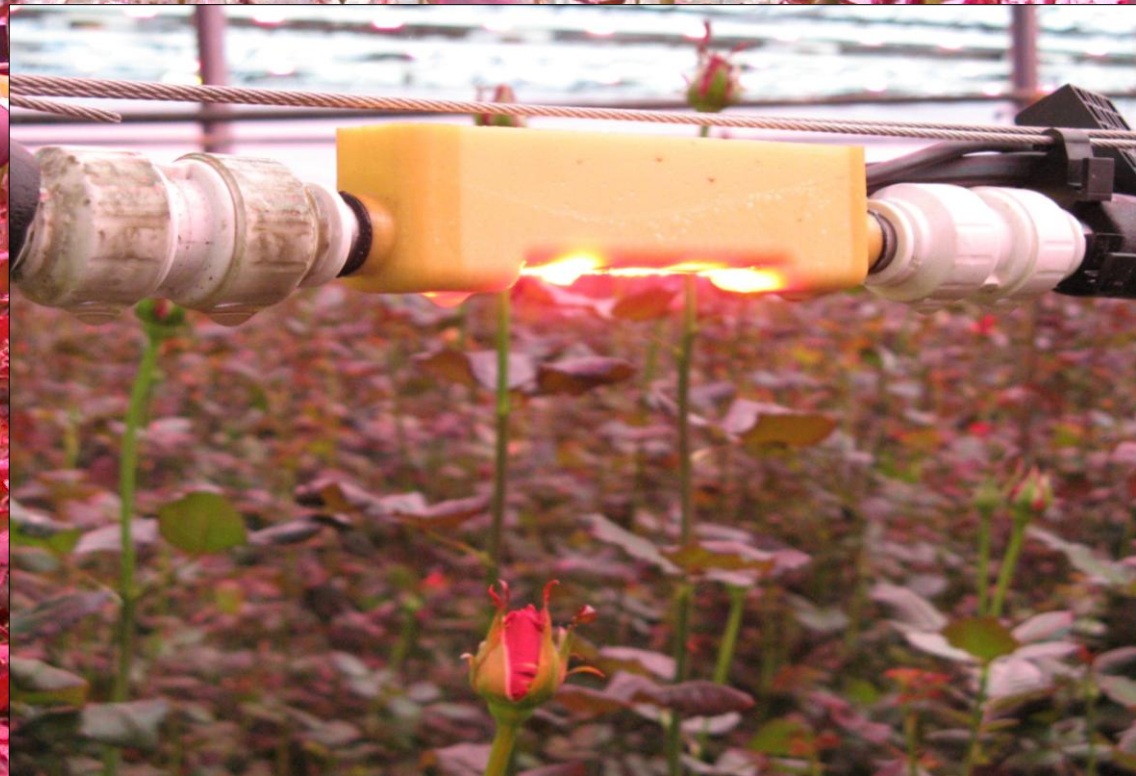




illuminazione assimilativa e illuminazione “di controllo”









*Interlighting*



*Intra-canopy lighting*

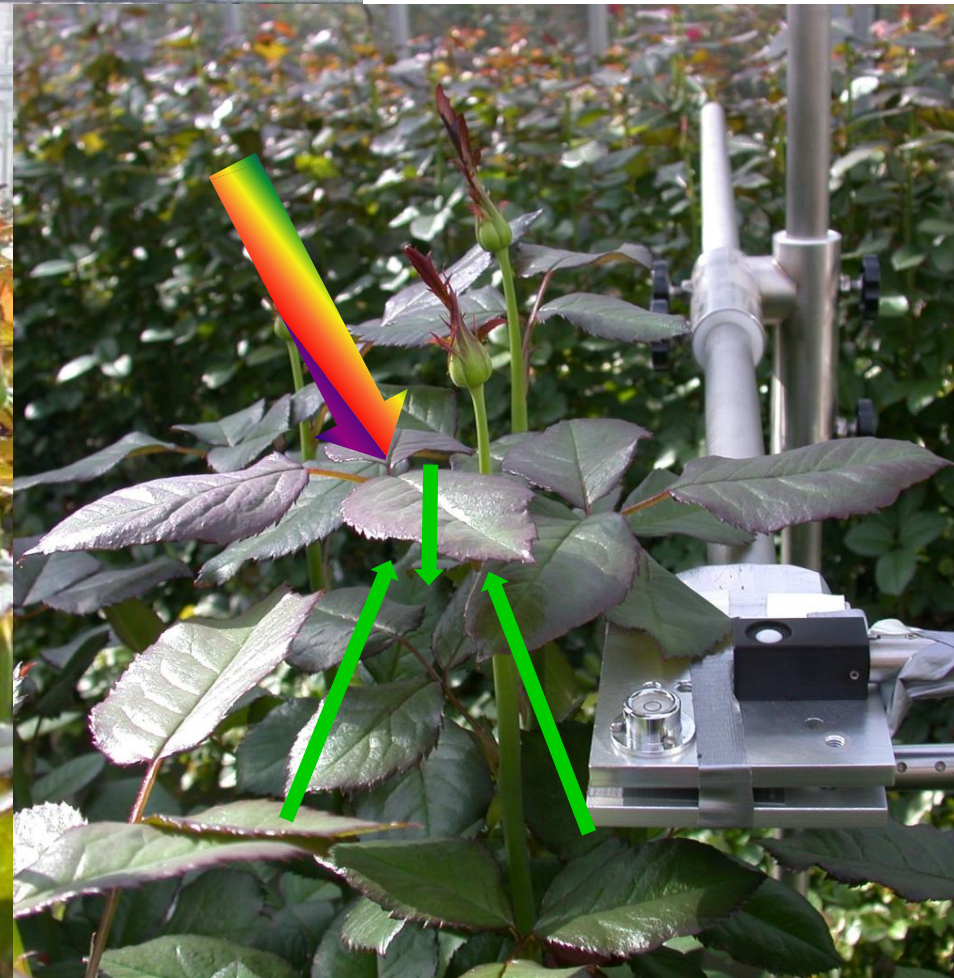




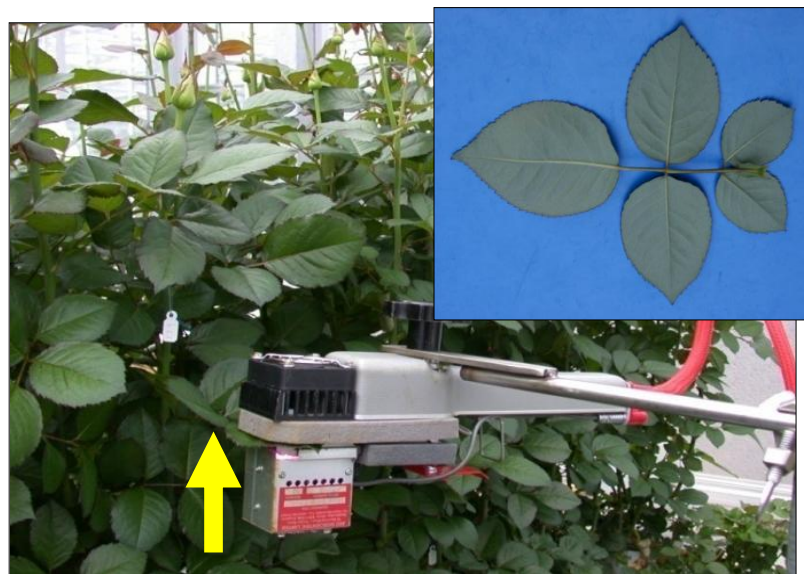
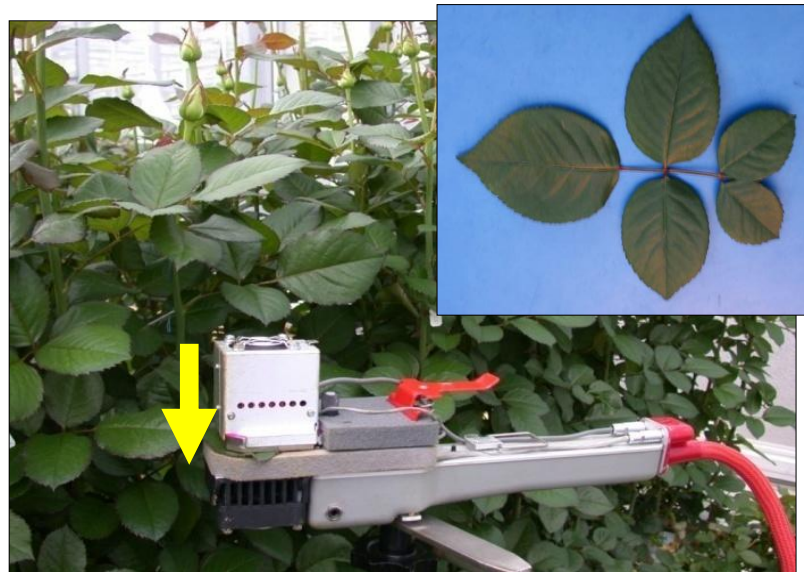
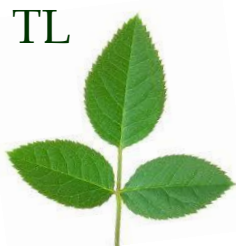
# Illuminazione assimilativa







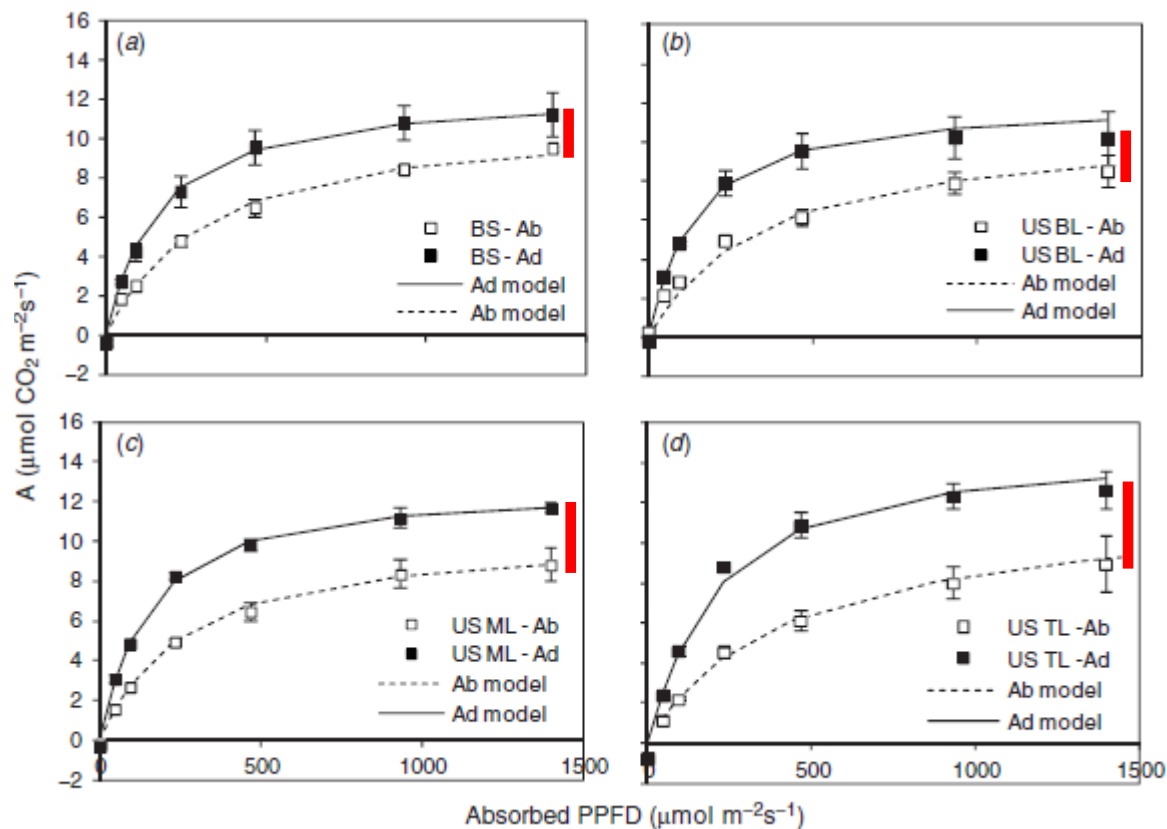
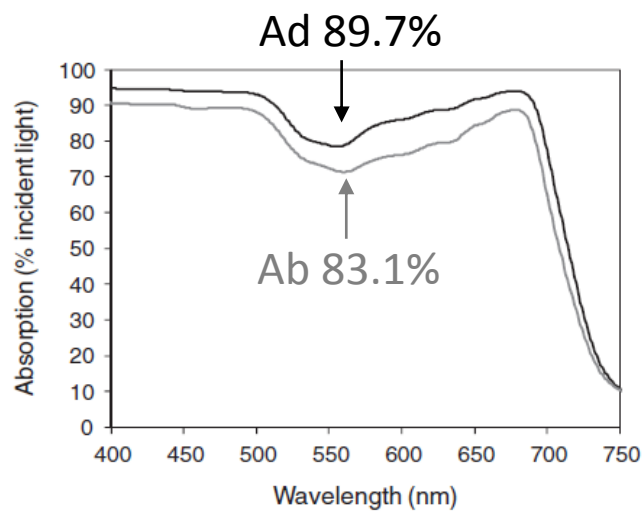




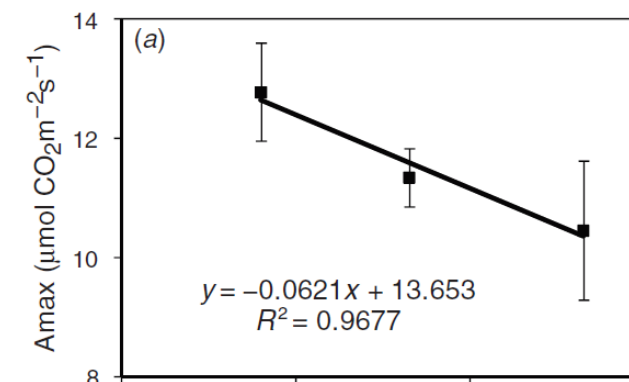


## Light response of photosynthesis

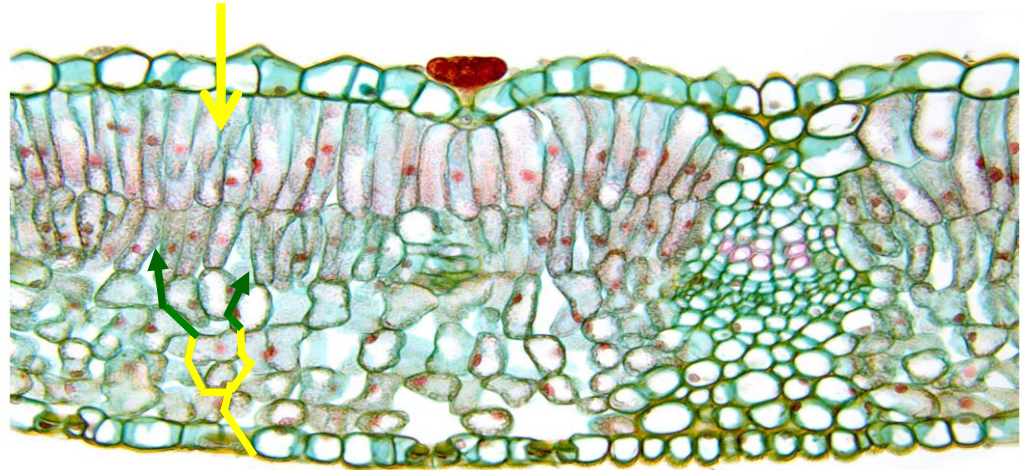
### Absorptance



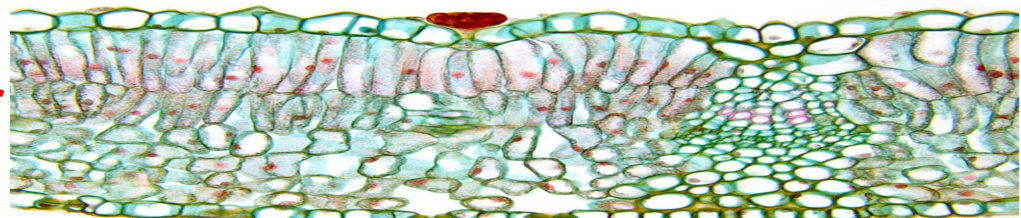
### Photosynthetic capacity



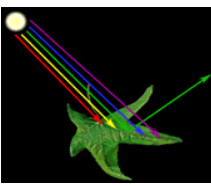




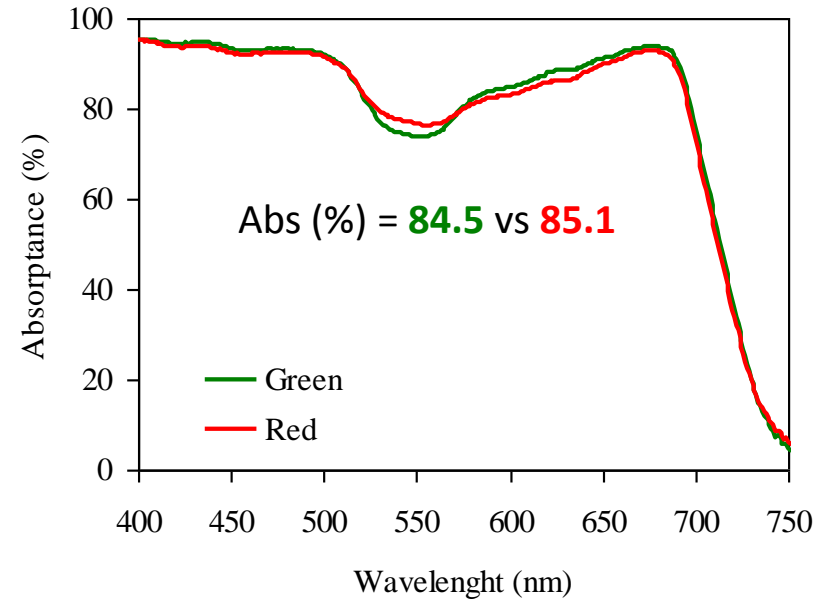
*Under adaxial lighting palisade cells act as a **light guide** to spongy cells, while under abaxial lighting spongy cells acts like a **light trap***



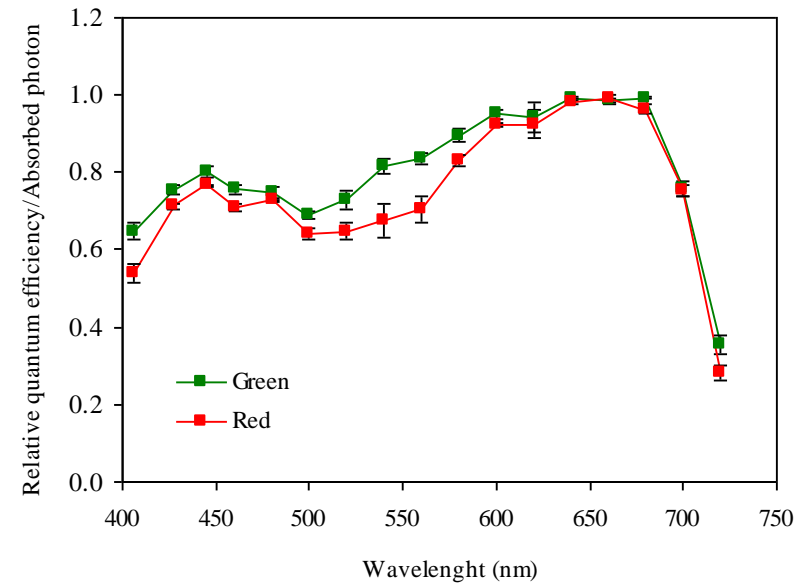




Light absorptance

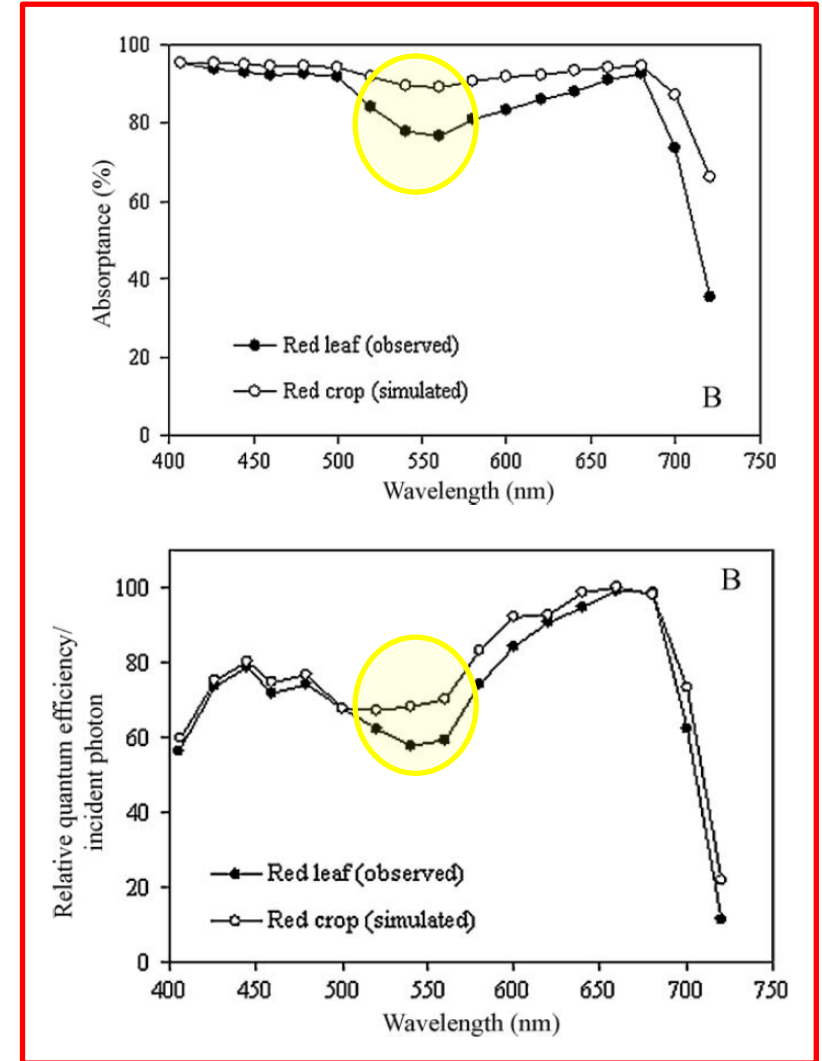
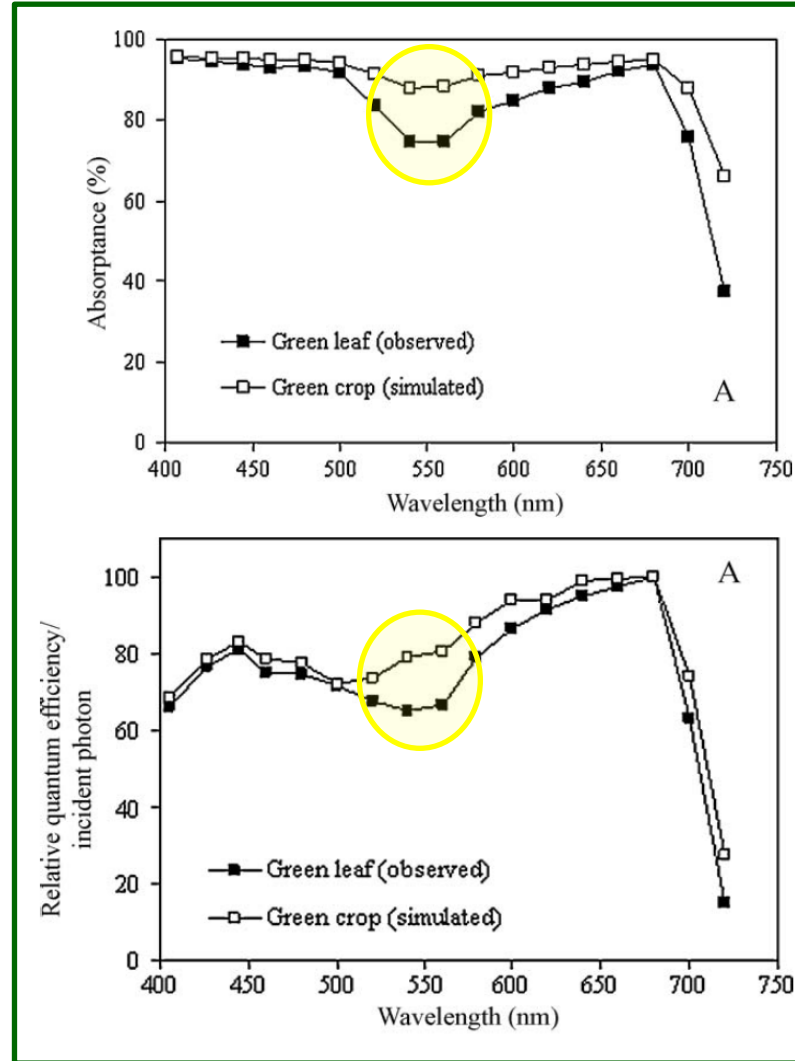


Quantum yield

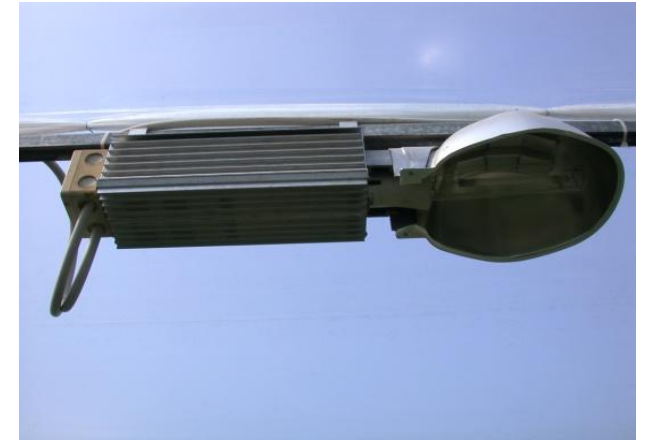
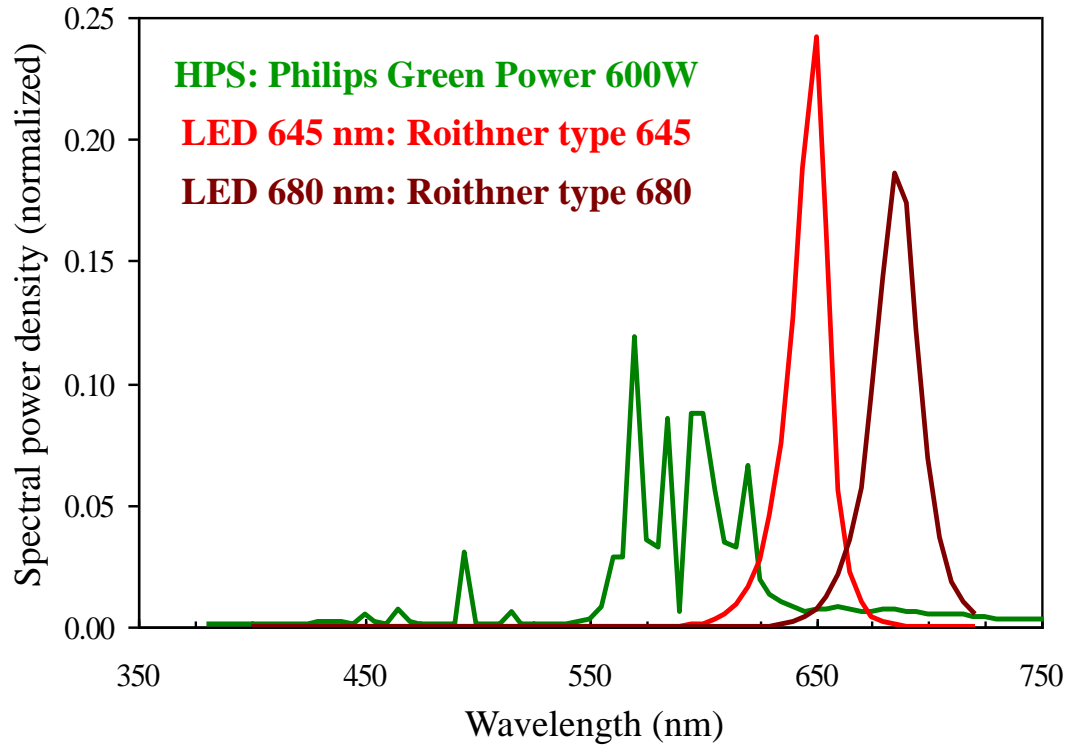




# Up-scaling single leaf → canopy







(simulated) Light Use Efficiency  
(per incident light, on single leaf, in short period)

	<b>LUE</b>	
	<b>(% max value under HPS)</b>	
	<b>Green</b>	<b>Red</b>
<b>HPS</b>	100	96
<b>LED 645 nm</b>	136	136
<b>LED 680 nm</b>	128	126

**645 LED's > 680 LED's > HPS**



# Illuminazione fotoperiodica

Qualità della luce e fioritura di *long day plants* (LDP)



*Giorno breve, SD (notte lunga):  
la riconversione in Pr  
promuove la fioritura delle SDP  
e la inibisce in LDP*

*Giorno lungo, LD (notte breve):  
l'accumulo di Pfr  
promuove la fioritura in LDP  
e la inibisce in SDP*

**PPE (Phytochrome PhotoEquilibrium) = Pfr/Ptotale**



*Petunia x hybrida*



*Antirrhinum majus*

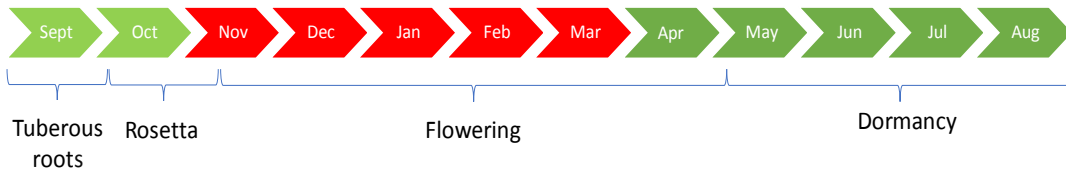


*Fuchsia x hybrida*

**PPE intermedio = 0.63–0.80**



# *Ranunculus asiaticus* L.



## Temperature

Vernalization requirement of the tuberos roots (?)

Temperature requirement: night/day: 5-10/12-25°C  
(optimum day T 16°C)

## Light intensity

Medium to high (PPFD: 500-1000  $\mu\text{mol photons m}^{-2} \text{s}^{-1}$ )

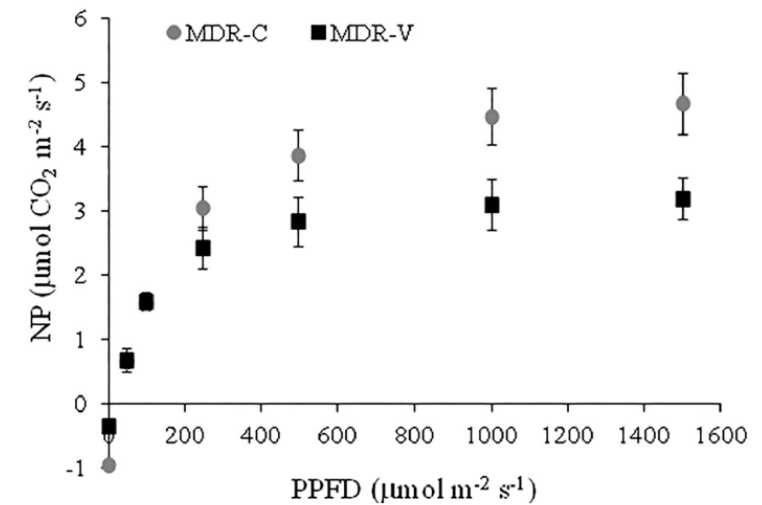
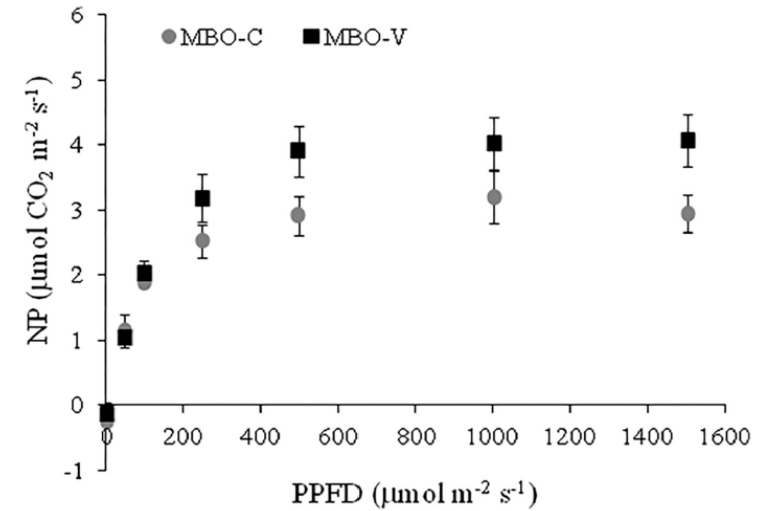
## Photoperiod

Quantitative Long Day Plant (> 13 Hours)

Photoperiodic light quality (?)



## 2 Hybrids x 2 Preparation procedures (climatic chamber)



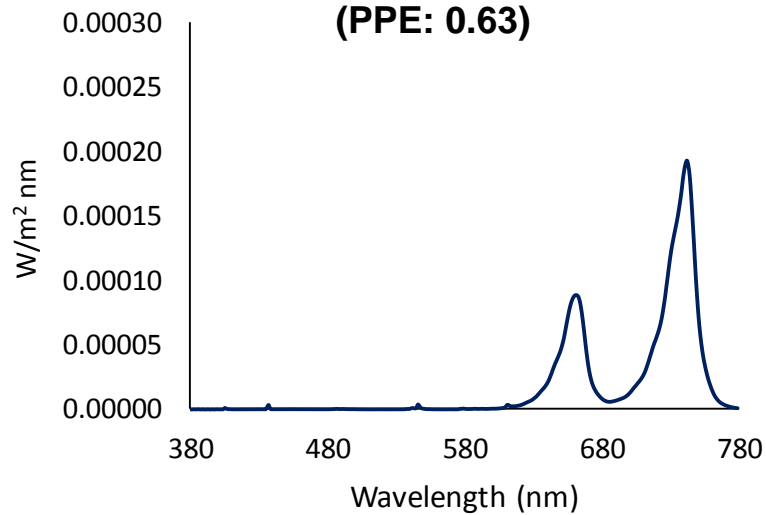


# 2 Hybrids x 2 Preparation procedures x 4 Photoperiodic treatments (glasshouse)

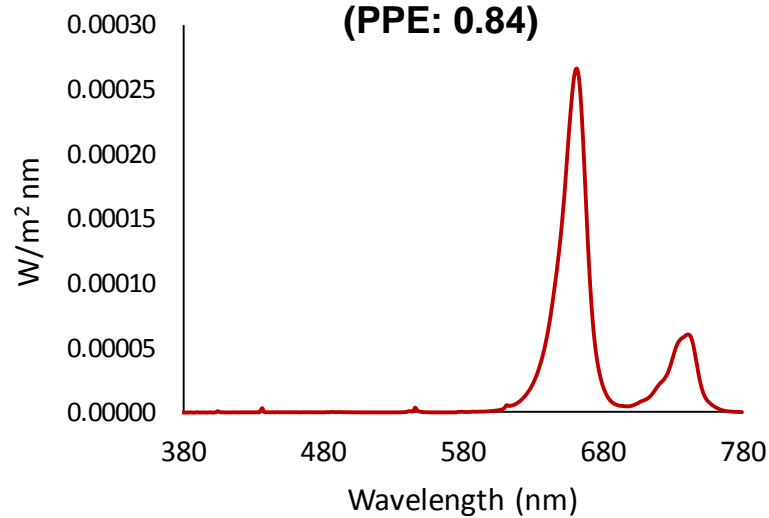
Photoperiod lighting: day extension to 14 hours, PPFD  $5 \mu\text{mol m}^{-2} \text{s}^{-1}$



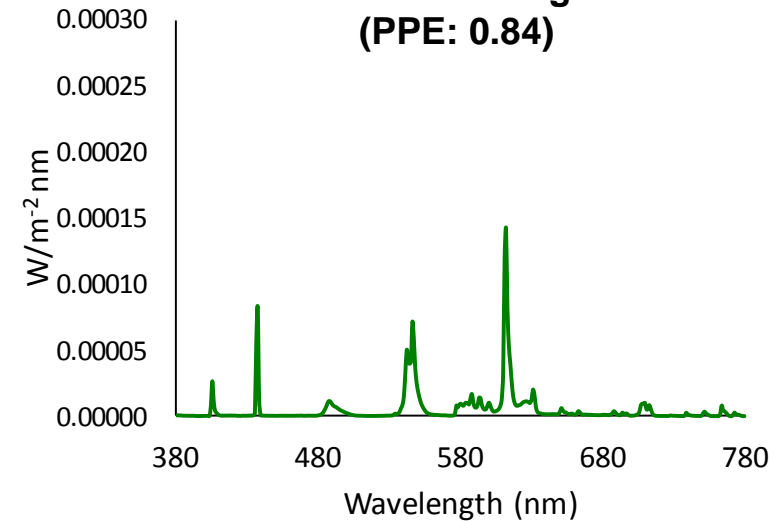
**R:FR:1:3  
(PPE: 0.63)**



**R:FR:3:1  
(PPE: 0.84)**

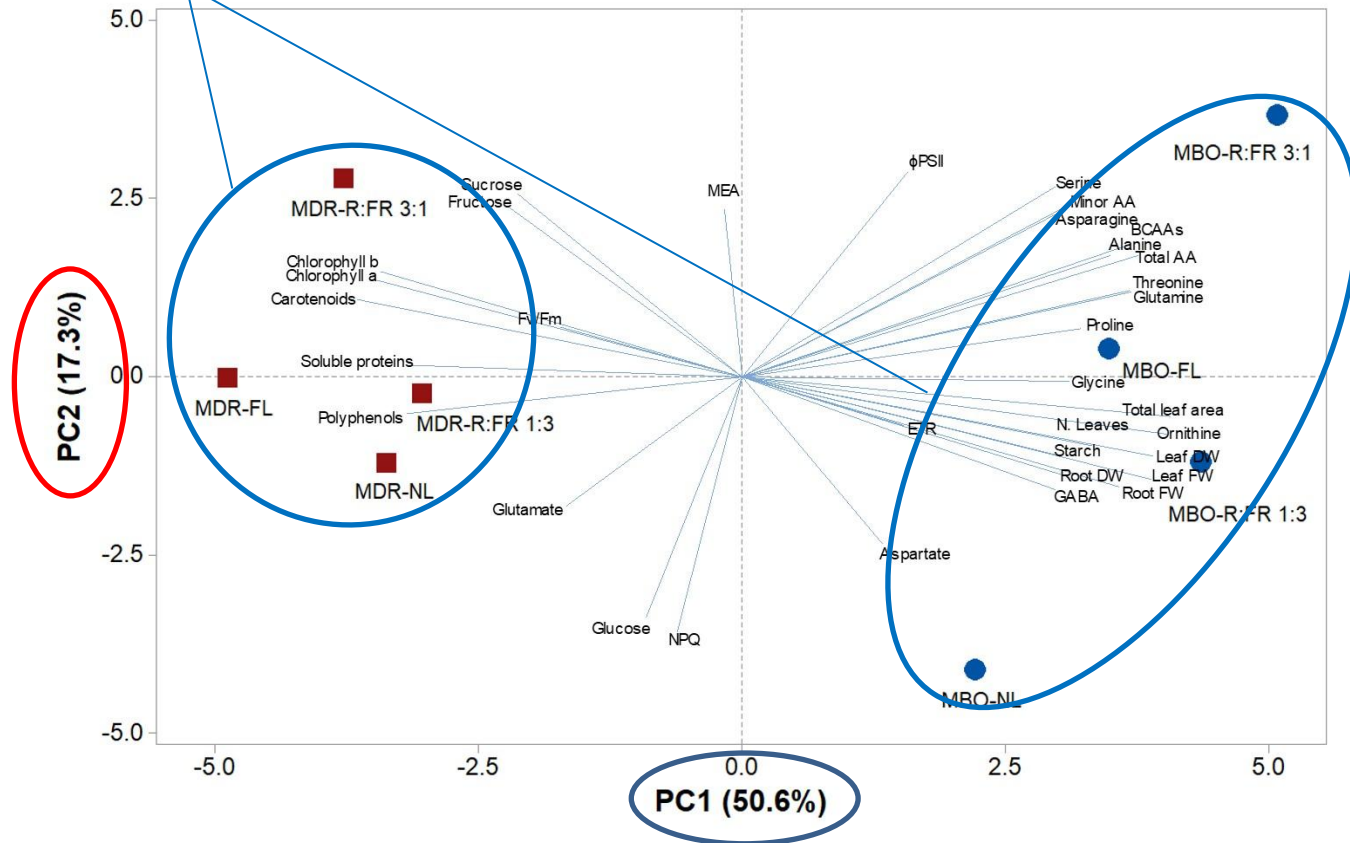


**Fluorescent light  
(PPE: 0.84)**





Intrinsic differences between the hybrids account for about 50% of variability!



Flowering earliness depends on metabolic response

LED R:FR 3:1 (high PPE) is the most effective

***Plant sensitivity to light spectrum is species- and genotype- dependent!***



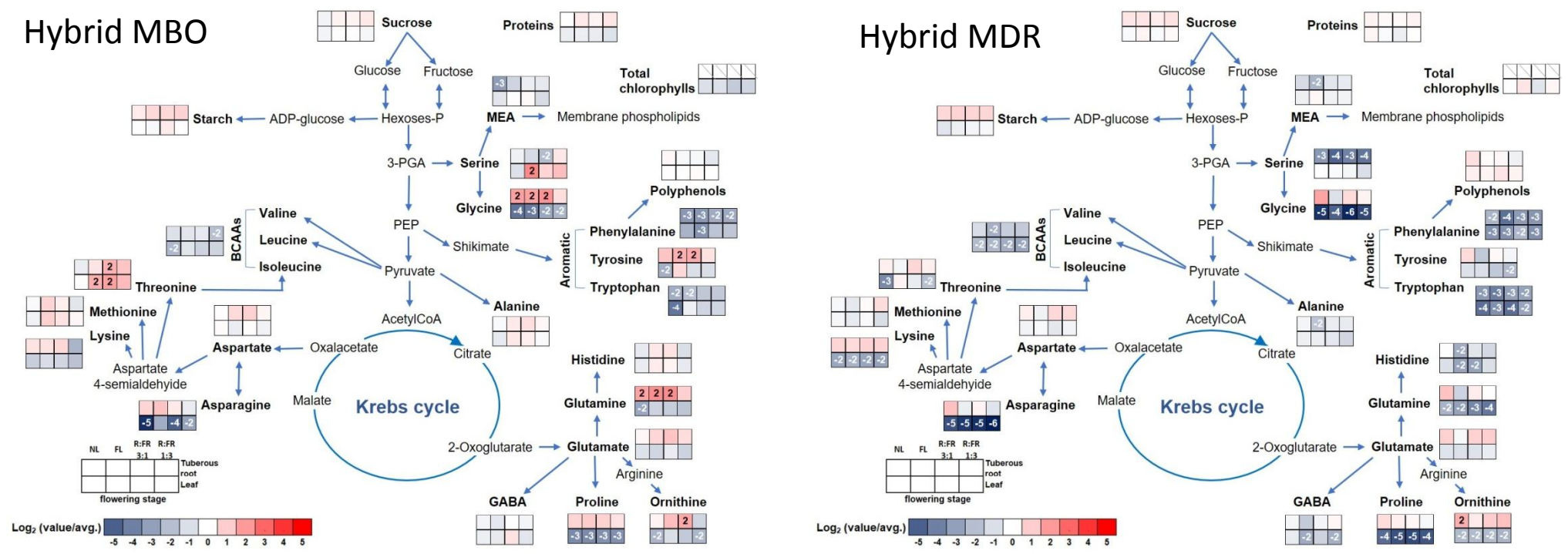


- Differences in reserve material and in metabolic response to cold determine flowering earliness in the genotypes
- Some changes in metabolic profile depend on day length and light quality, however most of the responses are under a **strict genetic control**

Pre-planting

Vegetative phase

Flowering

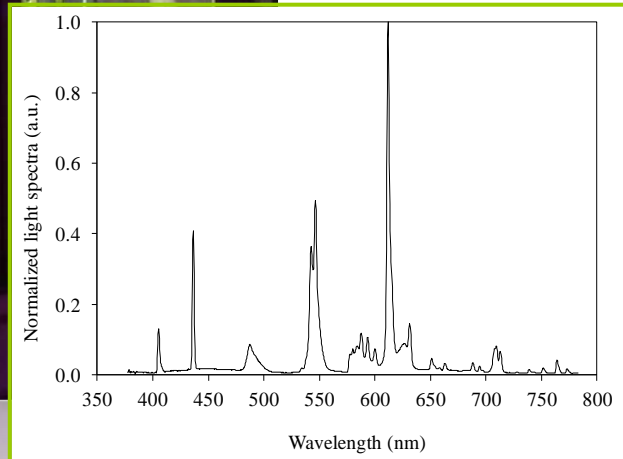
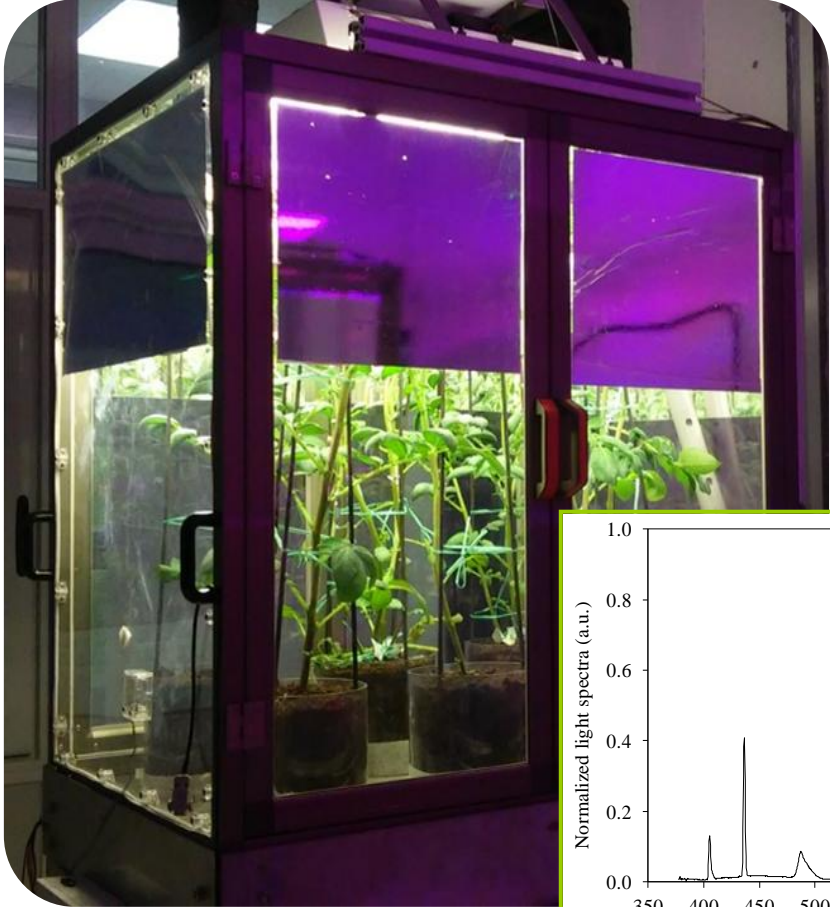




# Illuminazione sostitutiva

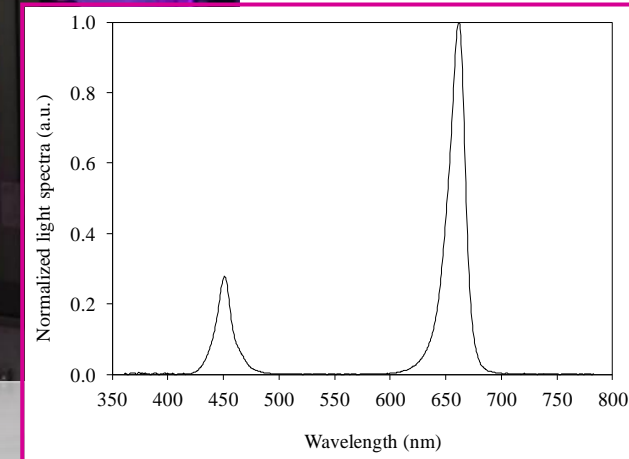
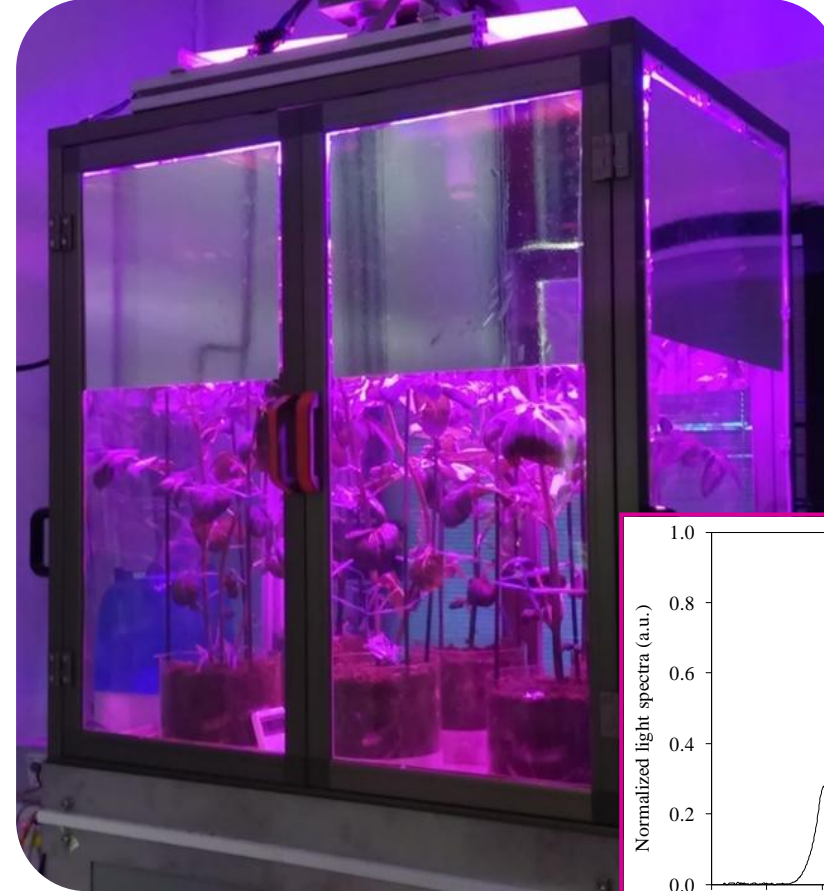
## *Solanum tuberosum* L.

Warm white light fluorescent tubes  
(Philips Sylvania Linx - LE 55W/830)



Red:Blue LEDs arrays (8:1 ratio)

each containing 16 LEDs 660 nm (Red) + 2 LEDs 445 nm (Blue)  
(Osram Oslon SSL 80 LH CP7P 1 W + LD CQAR 2 W)





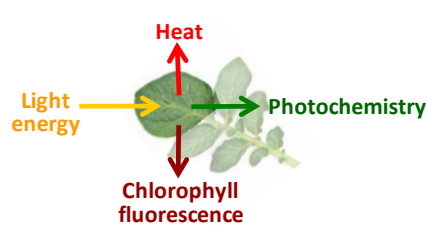
*White fluorescent tubes*



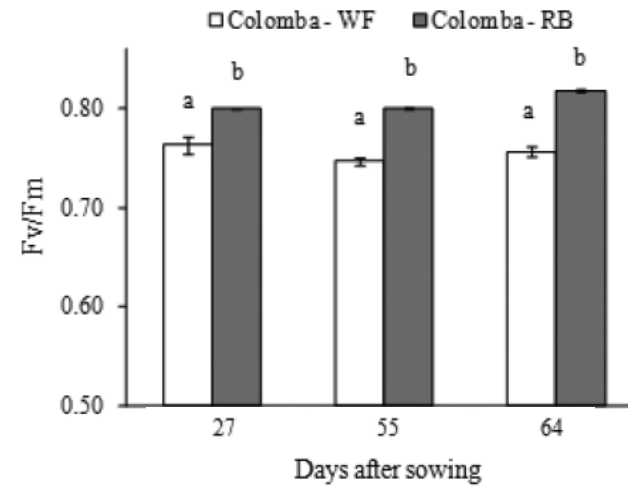
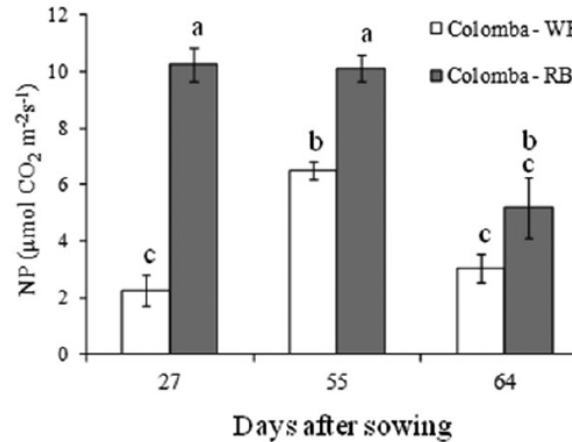
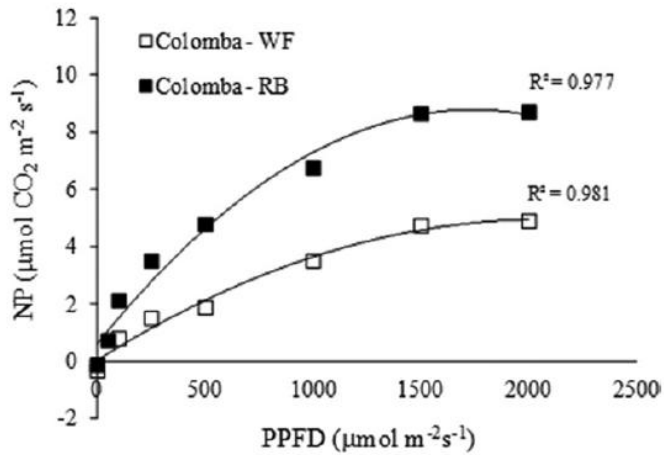
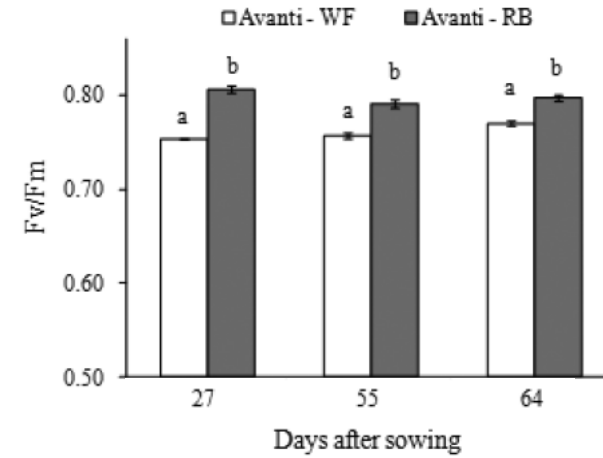
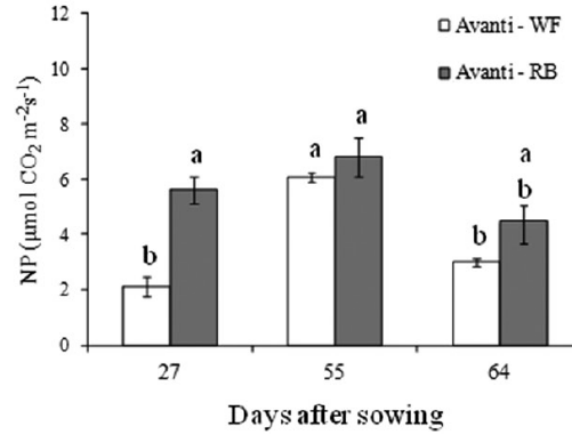
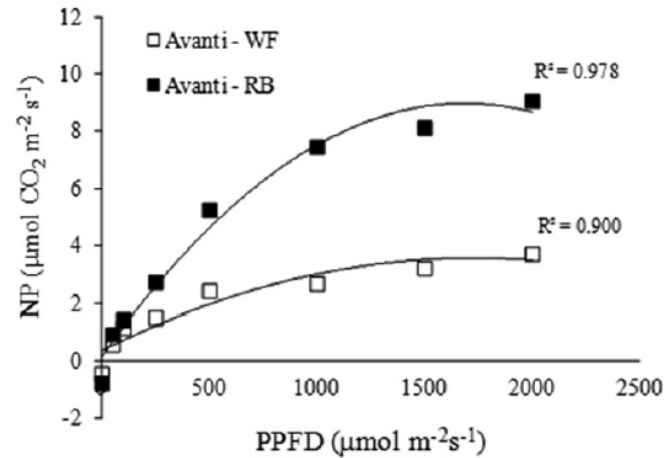
*LEDs panels*







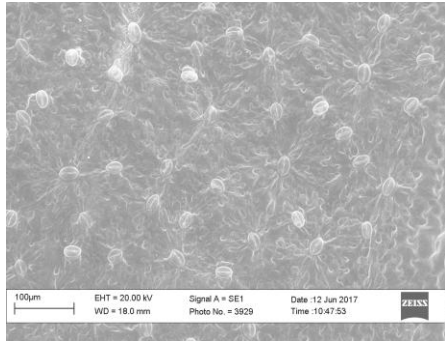
# Net Photosynthesis and Chlorophyll *a* fluorescence



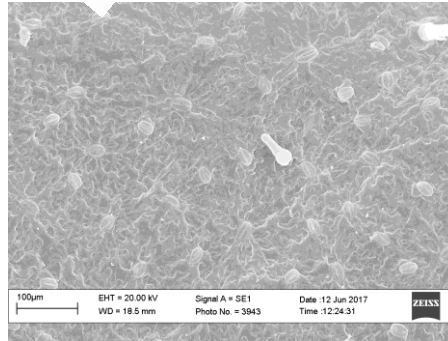




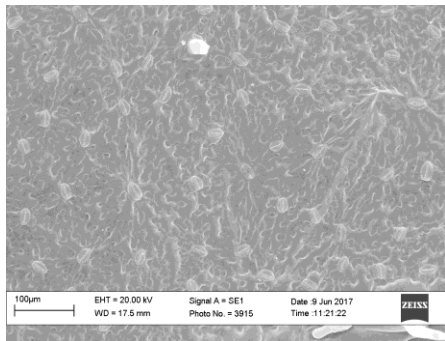
## Stomatal density



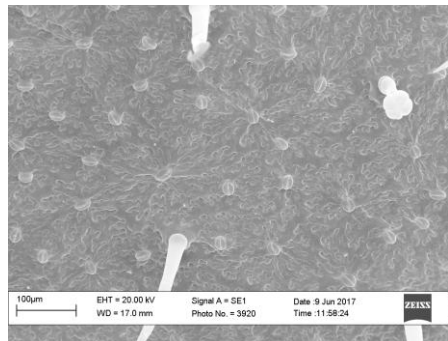
Avanti - WF



Avanti - RB



Colomba - WF



Colomba - RB



		Proteins (g 100 g <sup>-1</sup> dw)	Starch (g 100 g <sup>-1</sup> dw)	Total dietary fiber (g <sup>-1</sup> 100 g dw)	Total glycoalkaloids (mg kg <sup>-1</sup> dw)	α-solanine (mg kg <sup>-1</sup> dw)	α-chaconine (mg kg <sup>-1</sup> dw)
<b>'Avanti'</b>	WF	11.49 a	86.6	10.6 a	209.4	25.8 b	183.6 ab
	RB	8.08 b	91.0	9.8 b	217.4	20.5 b	196.8 a
<b>'Colomba'</b>	WF	9.13 b	87.3	9.6 b	264.5	56.2 a	208.3 a
	RB	8.95 b	88.6	7.0 c	205.9	99.3 a	106.6 b
Significance							
Cultivar (C)		ns	ns	***	ns	*	ns
Light source (L)		*	ns	***	ns	ns	ns
C × L		*	ns	***	ns	ns	*



# Bando MIPAAF - Florovivaismo biologico

## Fiori eduli biologici come fonte di alimenti nutraceutici e ingredienti salutistici - FLOUER

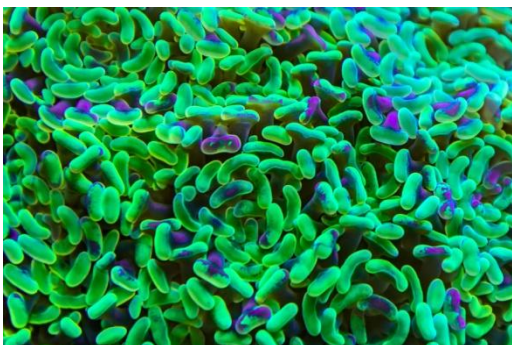
Coordinatore: Stefania De Pascale

U.O. DIA - Roberta Paradiso

U.O. DIF - Alberto Ritieni

in collaborazione con Danilo Russo

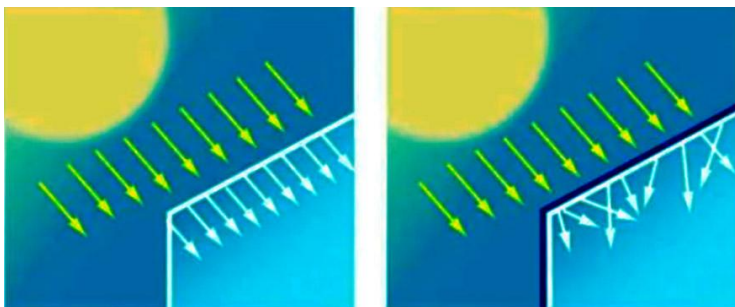
Microorganismi benefici



Coperture fotoselettive



Coperture diffusive



*Alpega Grower Società Agricola arl (Salerno)  
Nanometro zero Farmhouse Società Agricola arl - (Salerno)*





# Dottorato in *Food science* / Tesi di Laurea magistrale

Alberto Ritieni

/ Raffaele Romano

Il controllo dello spettro luminoso per il miglioramento delle proprietà nutraceutiche dei fiori eduli

## LED

- sorgente luminosa addizionale in trattamenti di breve durata o in maniera pulsata in serra (applicazioni in serre commerciali)
- sorgente unica in trattamenti di lunga durata in camera di crescita (applicazioni in *vertical farm*)

Effetti di blu, verde, rosso e rosso lontano su:

- caratteri agronomiche e fisiologici su piante in coltivazione (DIA)
- proprietà nutrizionali e nutraceutiche e sicurezza alimentare (DIF)





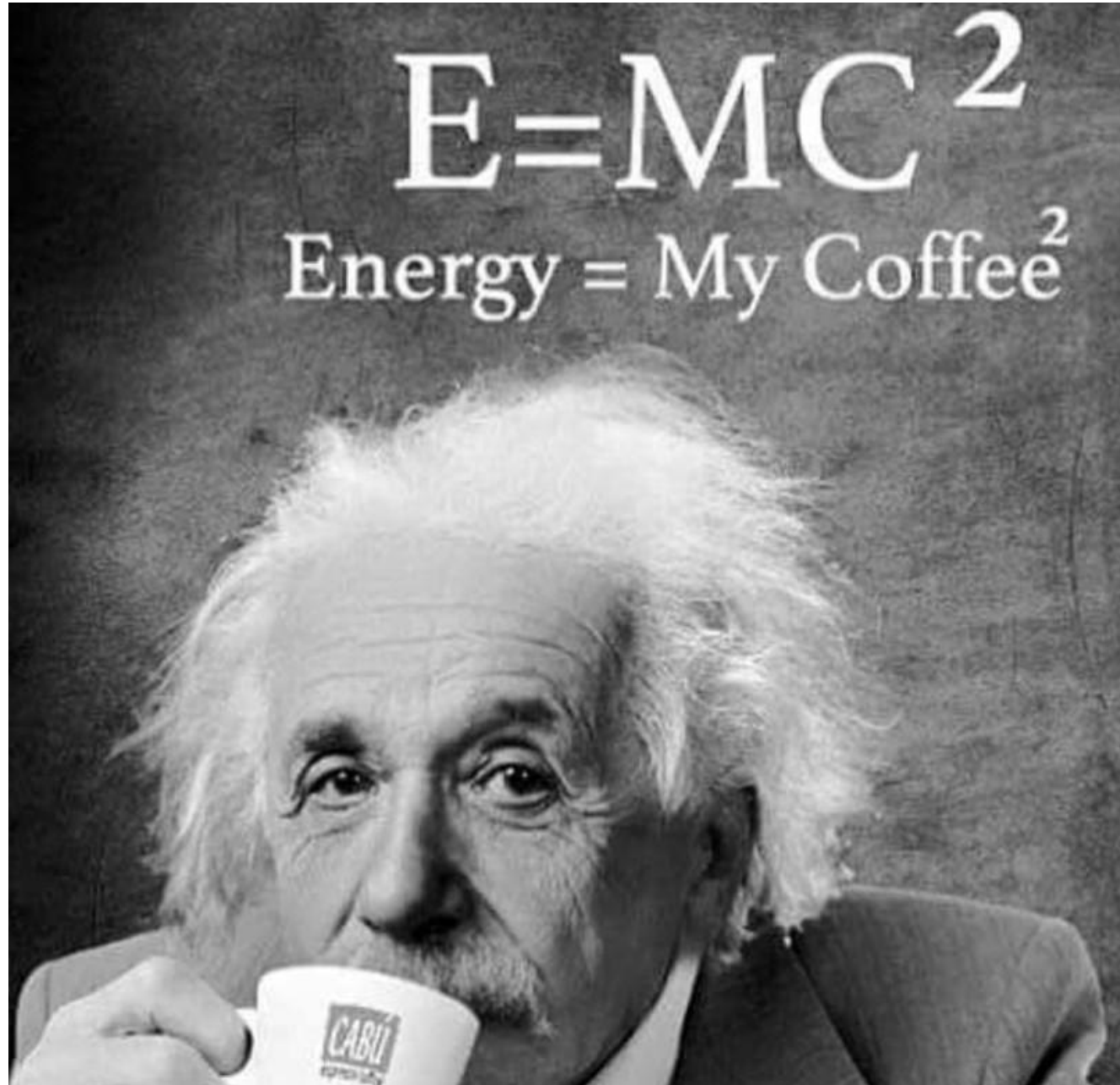


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Il miglioramento genetico della vite:  
quando tradizione e innovazione si incontrano  
Clizia Villano







Grazie!