

Light Spectrum: Improving Plant Quality

Licht Event

9 december 2015, Bleiswijk

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Wageningen UR Glastuinbouw



Plants sense their light environment:

Quantity (fluence rate)

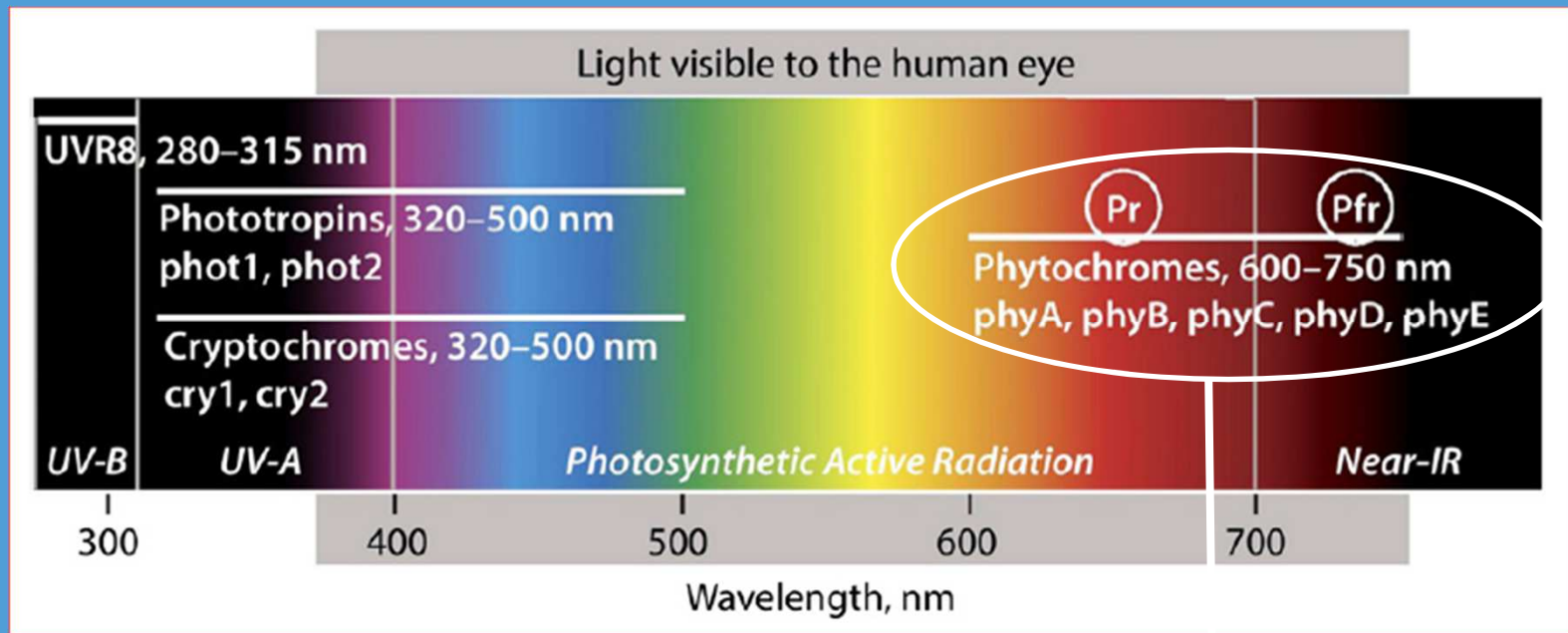
Duration (day length)

Direction

Quality (wave length/colour)



Light perception & Photoreceptors



- UVR8 – stress response
- Phototropins - phototropism
- Cryptochromes – daylength
- Phytochromes – R:FR

Physiological response via hormones, e.g. flowering



How to steer light?

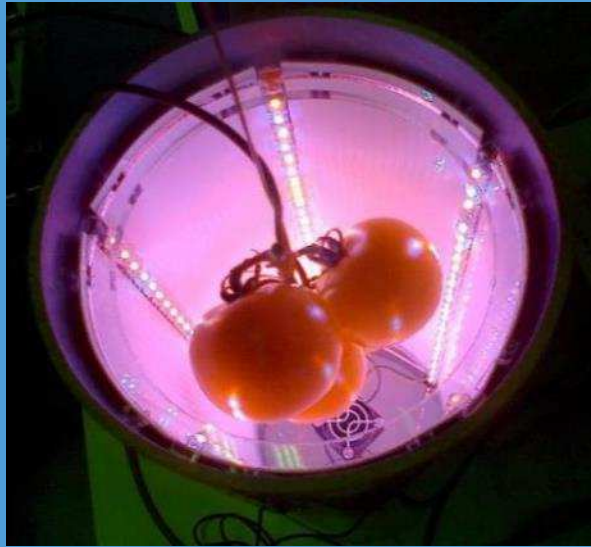
- Sunlight, change in R:FR, dusk, dawn
- HPS, limited spectrum
- LEDs have possibilities for spectral manipulation = tools
 - Choice of wave length (combinations)
 - Dimming
 - Long life-time (ca. 50,000 h)
 - Low radiative heat production



R



LEDs near/in the crop

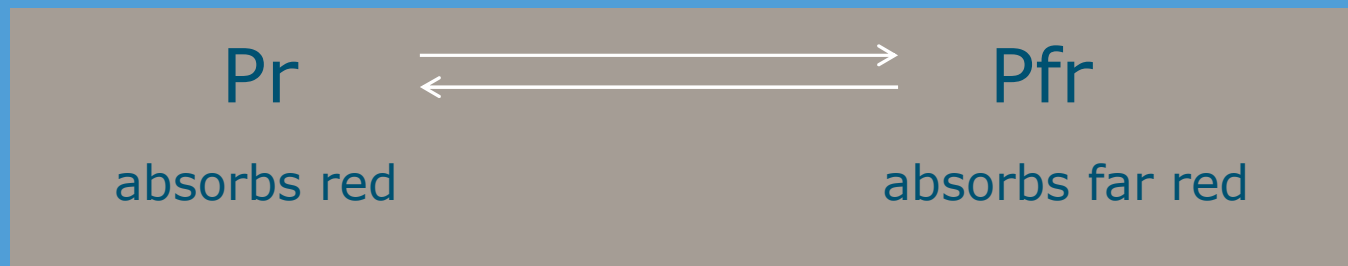


Total light control in a multi-layer system



Phytochrome

- Phytochrome changes in form and function ~ red and far red wave lengths



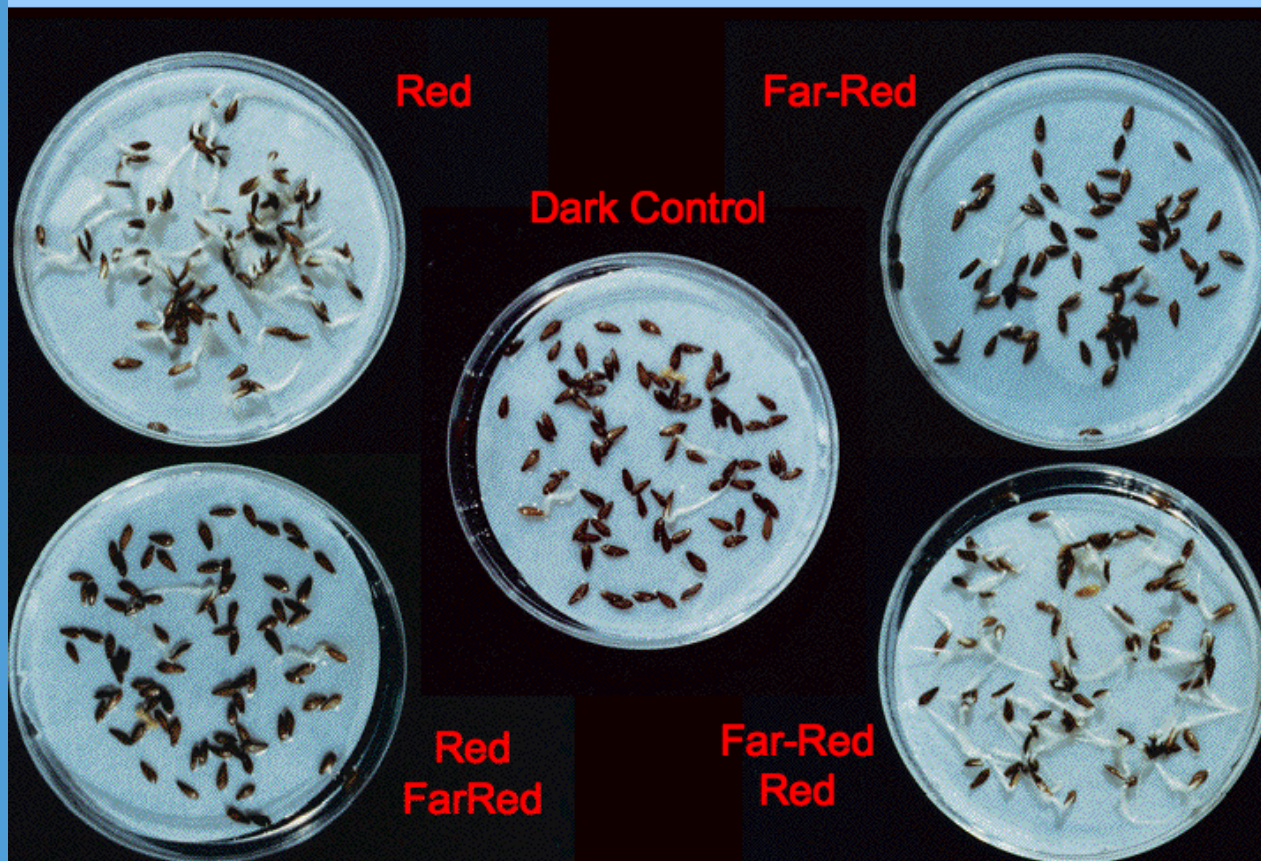
- Pr – absorbs red light (660 nm)
 - Stem and cell elongation, flowering
- Pfr – absorbs far red light (730 nm)
 - Germination at low light intensities, perceives day length



Red:far red ratio

- Plant response depends on red:far red ration ->
sunlight 1:2
light under leaves 0.13

Lettuce Seed Germination Responds to Light



Night interruption
by red light

Germination
depends on last
light(colour) flash

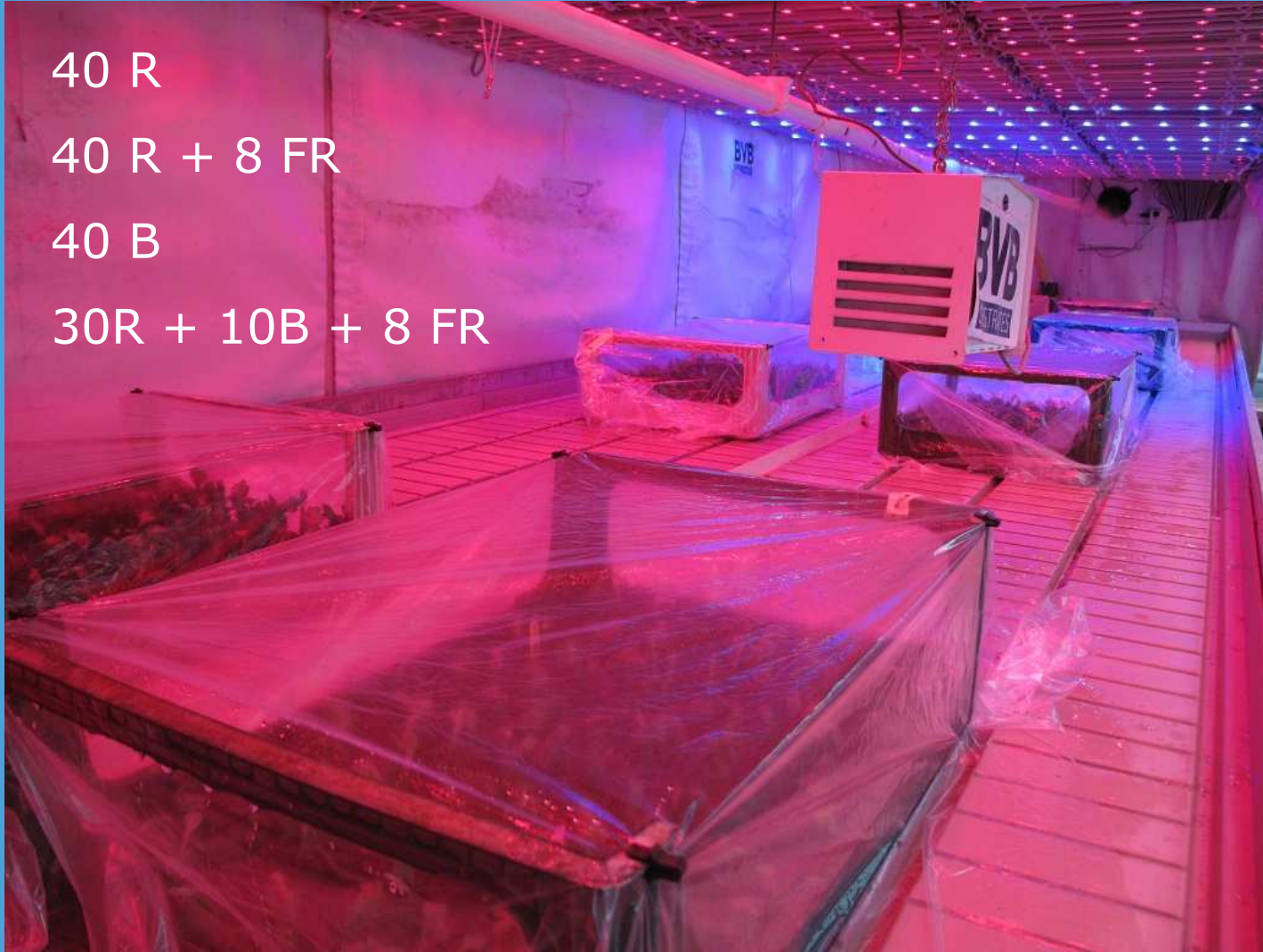
Rooting in Chrysanthemum, ca. 10 d

40 R

40 R + 8 FR

40 B

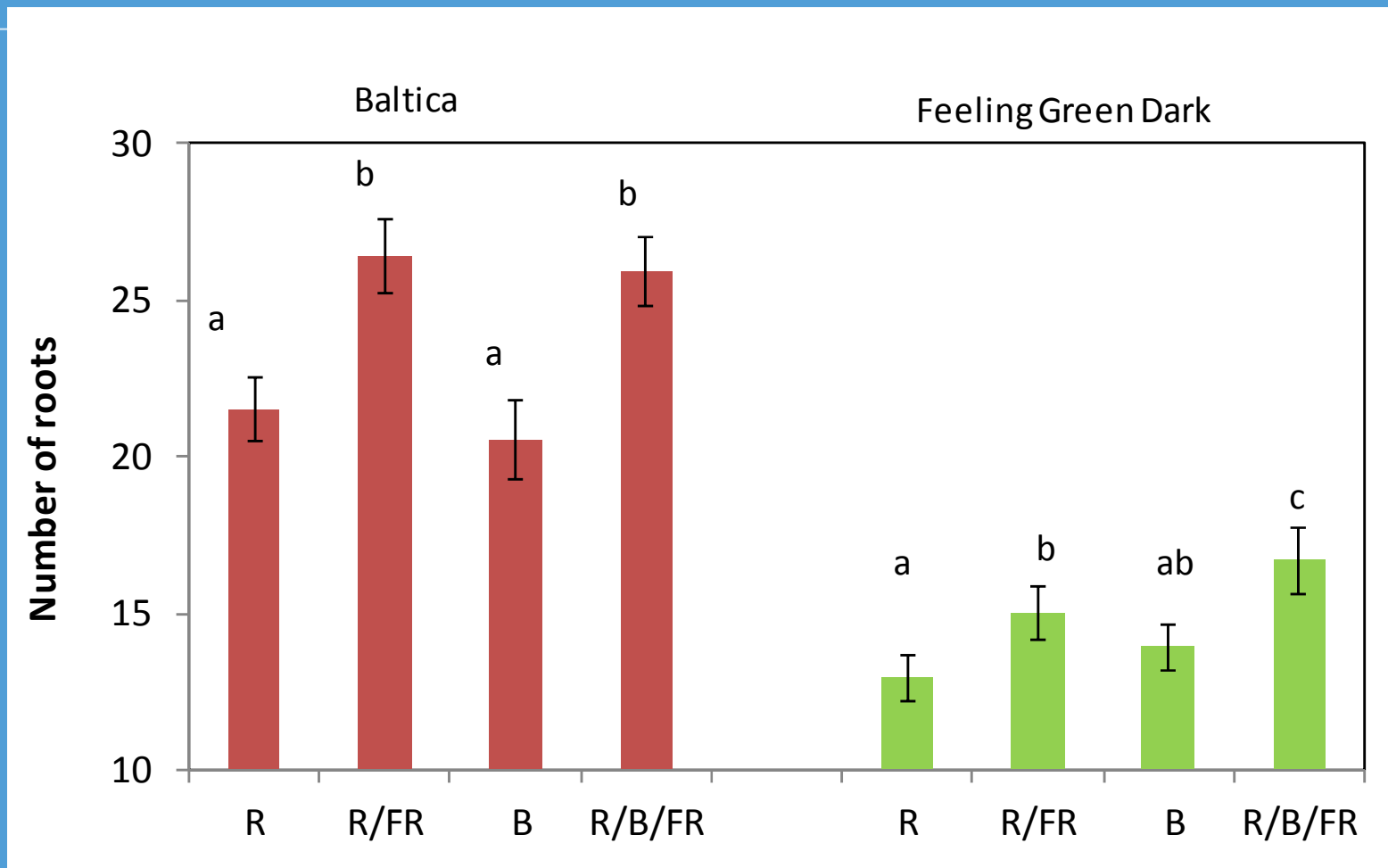
30R + 10B + 8 FR



Measuring roots



Influence of red, blue and far red light on rooting of Chrysanthemum



Induction of flowering in Phalaenopsis

- Grown at 28°C, cooled to 19°C to induce flowering
- Cooling costs energy in summer
- Can light quality help to save (cooling) energy?
- “red light” predominates in winter (lamps)
- “far red light” predominates in summer (sunlight)



Bloei-inductie bij Phalaenopsis

- Bloei-inductie ca. 6-9 wk
- Per bladoksel – 2 bloemknoppen
- Proces
 - Doorbreken knoprust
 - Groei van bloemtak(ken)
 - Bloemknop inductie

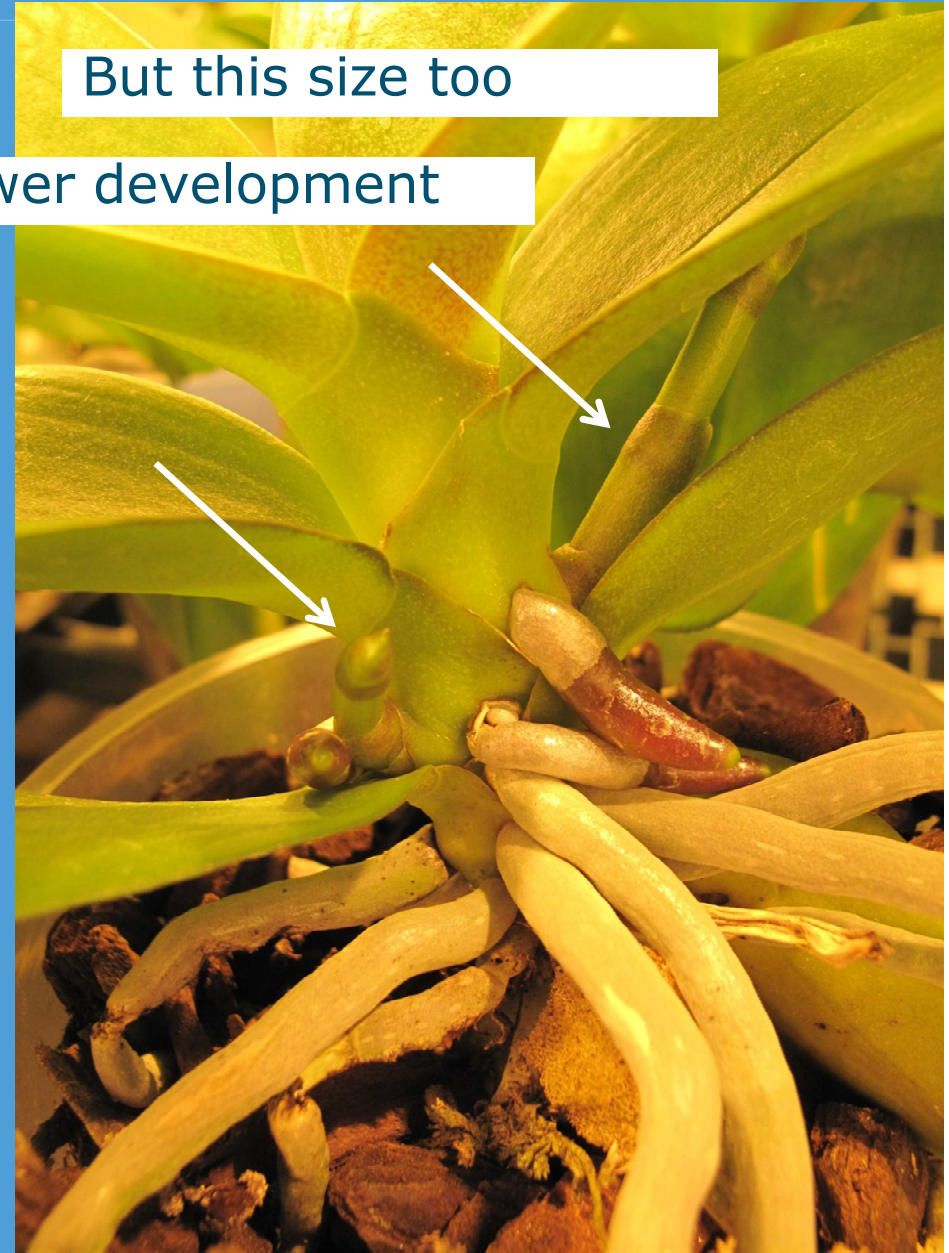
- Proces – sturing van hormonen-balans via temperatuur of licht



This size at 4 weeks,

But this size too

= difference in flower development



Effect of red vs. far-red with and without cooling

Cooling (19°C / 22°C)	Light color (red / far-red)	Multiple flower branches
Yes	Red	Yes
Yes	Far-red	Yes

Cooling always induces multiple flower branches

Effect of red vs. far-red with and without cooling

Cooling (19°C / 22°C)	Light color (red / far-red)	Multiple flower branches
Yes	Red	Yes
No	Red	Yes

Red light induces multiple flower branches, whether cooled or not



Effect of red vs. far-red with and without cooling

Cooling (19°C / 22°C)	Light color (red / far-red)	Multiple flower branches
Yes	Far-red	Yes
No	Far-red	No

Far red light treatment less effective without 8 weeks of cooling.



Inhoudstoffen – algae cultivation



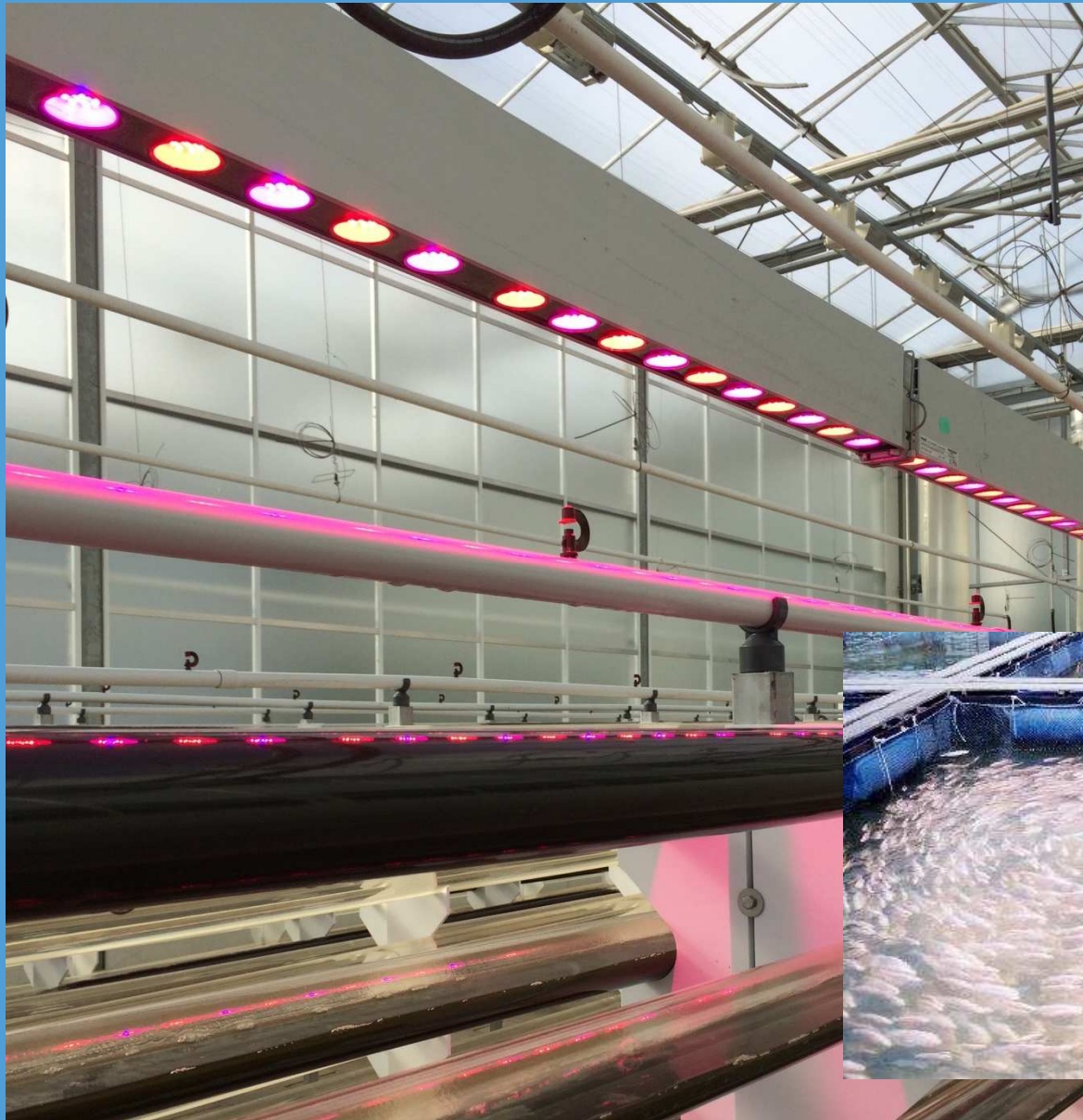
Cultivating for production of astaxanthine, a carotenoid and very strong antioxidant

- no red light -



Hemming et al., 2015

Astaxanthine production



Astaxanthine - with red light

Red pigment in e.g. salmon, shrimps and crabs



Indigo for Denim

Azia, South America

Indigofera spp.

Indican (intense blue)



Europe

Polygonum spp.

Indican (less intense blue)

Commercial production
with red light, more light
(longer day), CO₂ and
spacing

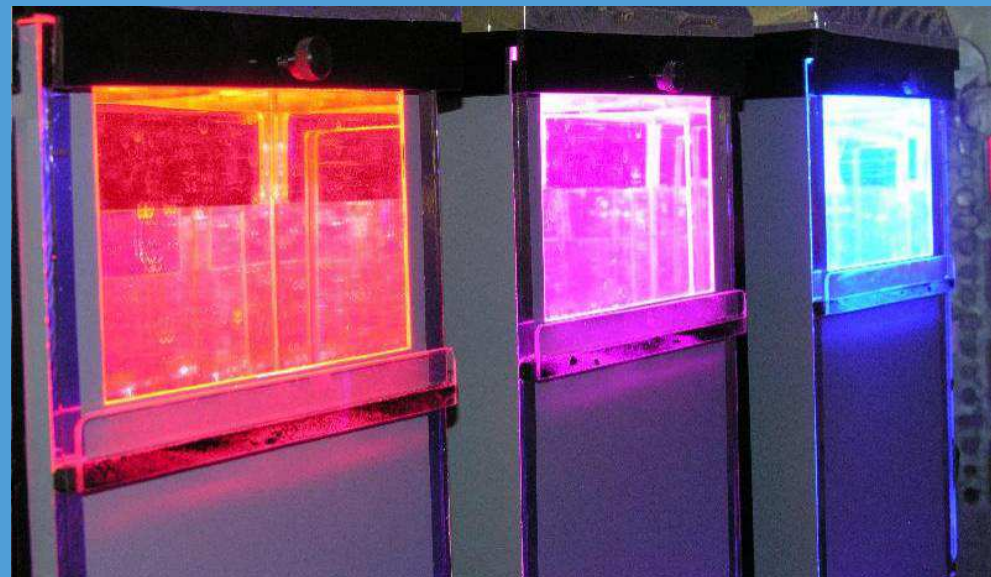
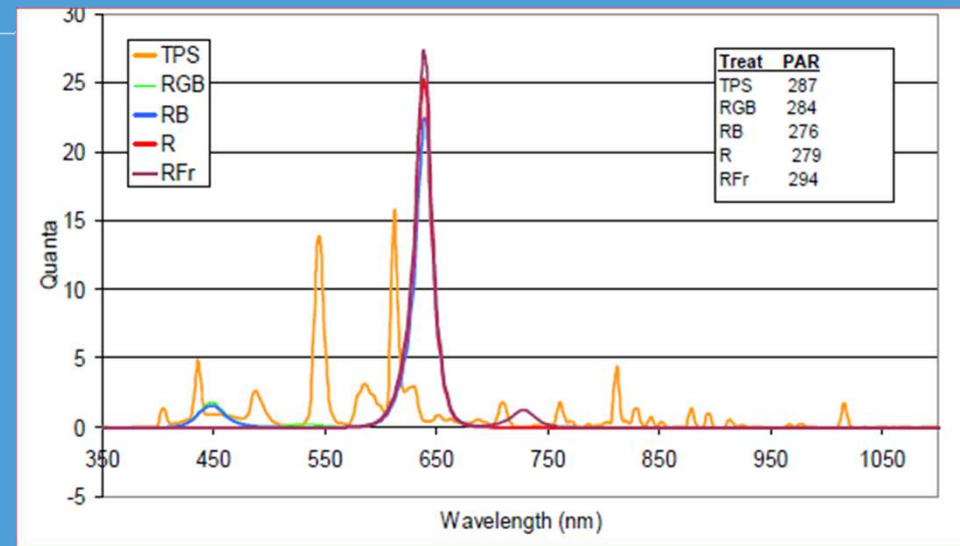
Increased production and
colour



Bioprotective plants in space

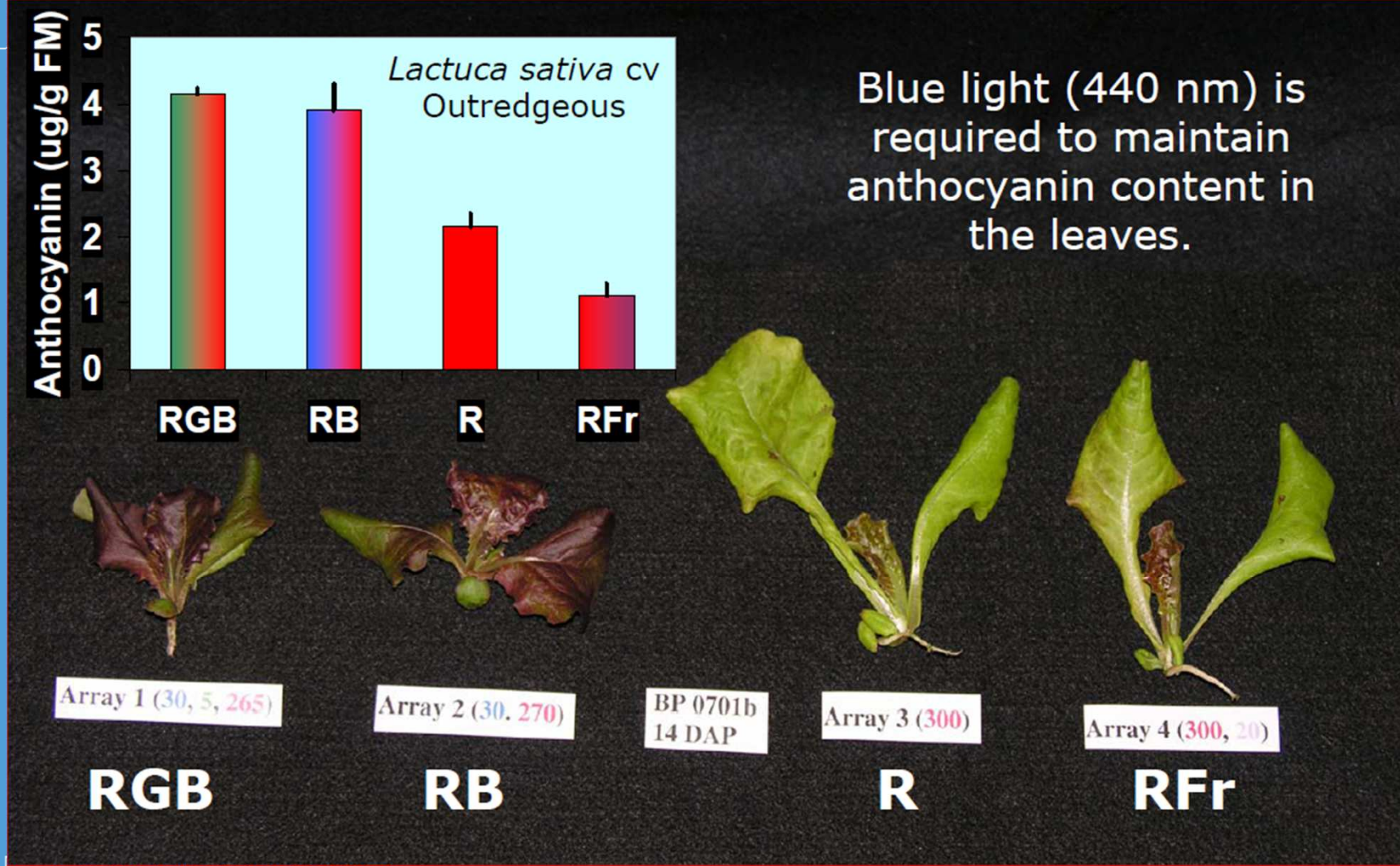


Lactuca sativa, red lettuce



Stutte et al. 2008

Light quality affects anthocyanin, protective pigment



Wageningen UR Greenhouse Horticulture

What can a strawberry
give us that we can't
already taste?

