Light Research in horticulture: use of supplementary light

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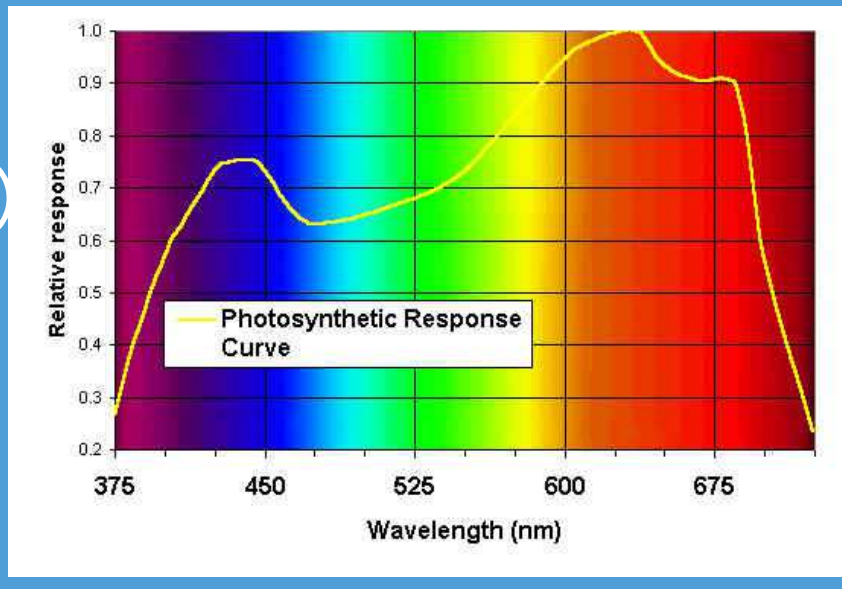
Plants use light for 2 things:

- Growth via photosynthesis → **Grow light**
  - PAR (400 - 700 nm)
  - Light intensity * duration = light sum
  - Tomato, rose
- Quality (plant shape, flowering) → **Steer light**
  - UV, purple, blue (300 - 450 nm)
  - Red (600 - 700 nm);
  - Far red (700 - 800 nm)
  - Day length (eg. SD plant)
  - Pot plants, cut flowers



Grow light – light for more biomass

- HPS

1.8 µmol/W

- LED toplight

2.3 µmol/W

- Hybrid HPS/LED

1.9 µmol/W

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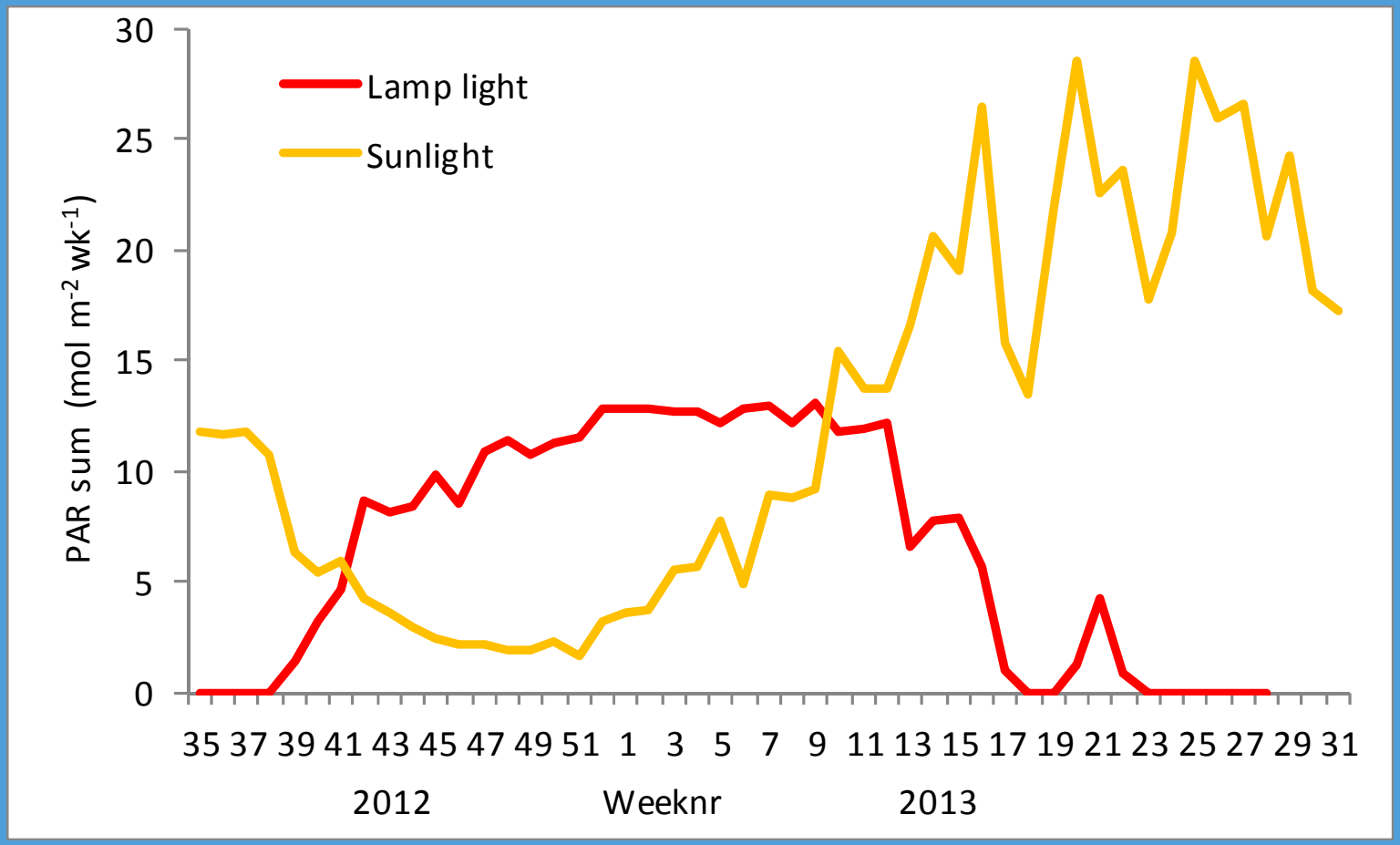
Application of hybrid lighting

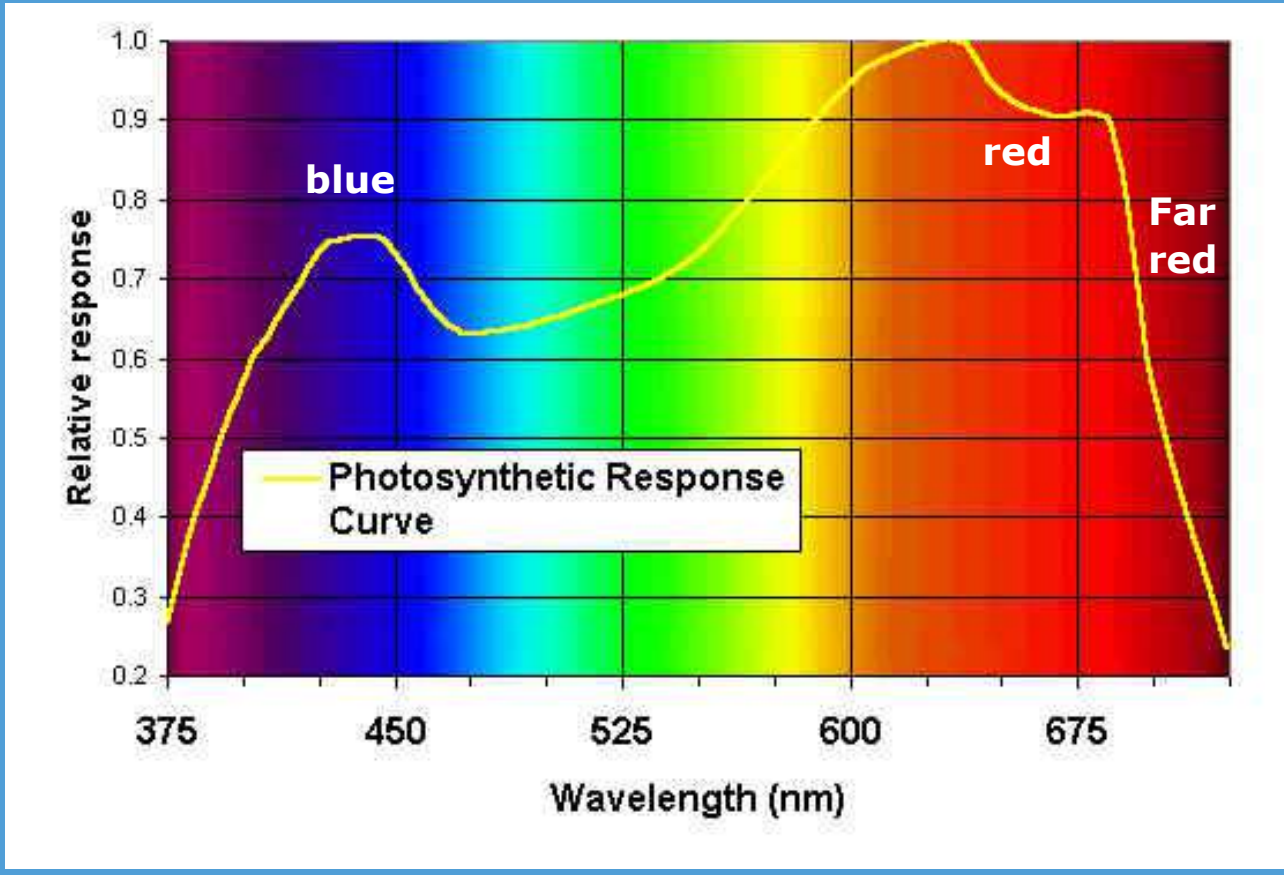
- Tune assimilation light to crop requirement
- Calculate light requirement according to crop (fruit) load in time
- Light requirement = sun light + lamp light
  - Sunlight is known (last 5 next 3 days)
  - Lamp light – number of extra hours necessary is then known as well
- HPS lighting out at 200 W radiation
- LED lighting out at 400 W radiation (longer use in spring is possible)

Annual PAR sum in the greenhouse



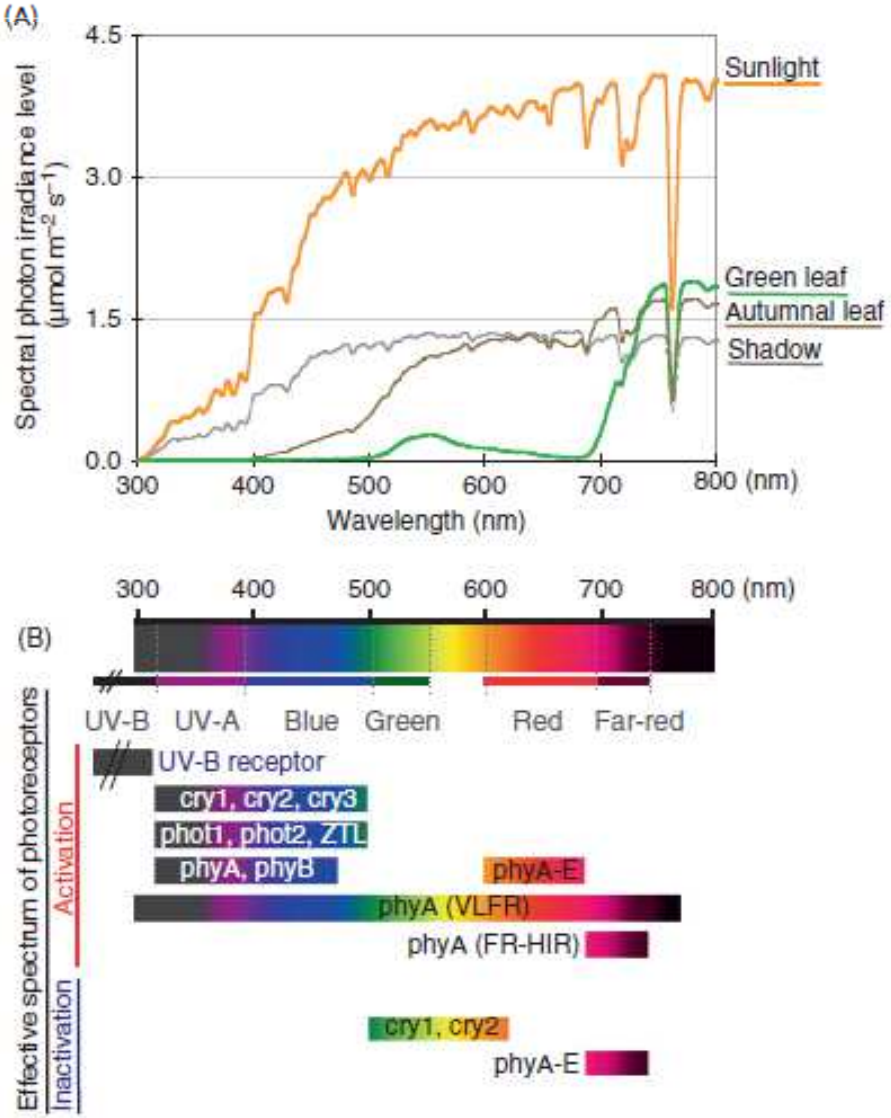
Light to steer plant development

- Low light intensities
- Specific wave lengths
- Ratio's of wave lengths



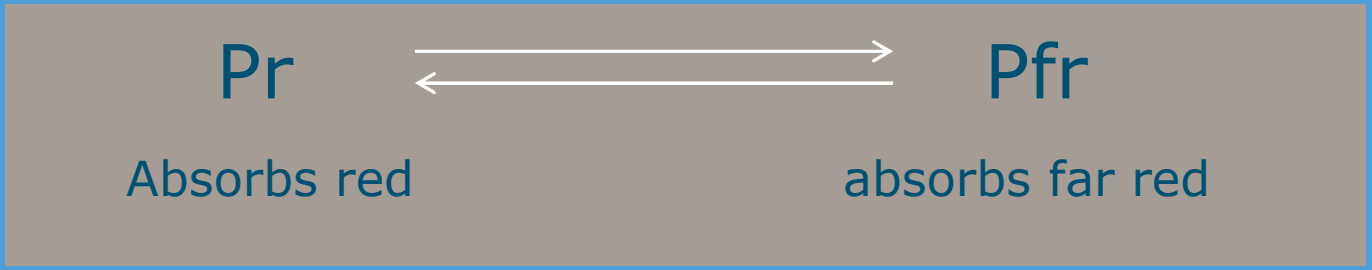
Photoreceptors

- Phytochromes
  - Red:far red
  - Germination
  - flowering
- Cryptochromes
  - Blue
  - photoperiodism
- Phototropins
  - Blue
  - orientation



Phytochrome

- Phytochrome changes in form and function in dependance of red:far red ratio



- Pr – absorbs red light (660 nm)
  Etiolation, elongation, flowering

- Pfr – absorbs far-red light (730 nm)
  Germination at low light, signal of day length

Phytochrome (2)

Flower reactions

- LD en SD plants (daylength determined flowering); day neutral plants (cold of heat sum determined flowering)

Growth reactions

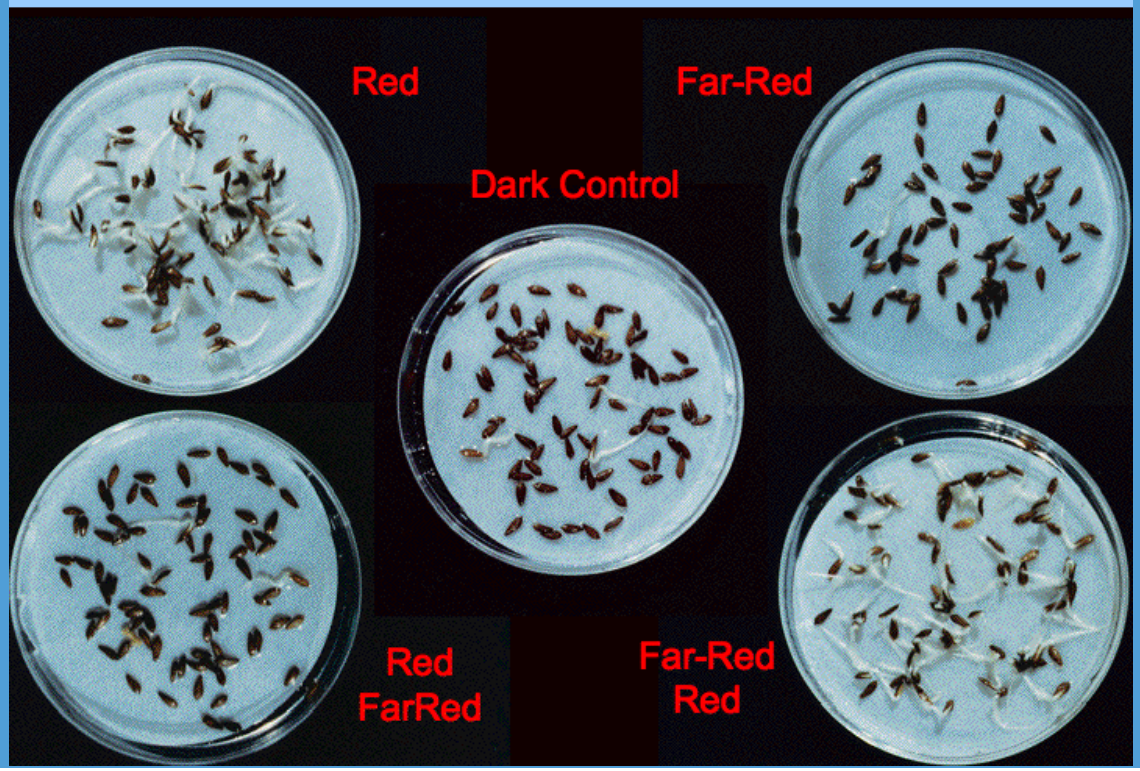
- Germination in ground, inhibits stretching seedling
- Chlorophyll production, leaf growth, upright growth

Red:Far red ratio

Elongatation →

Germination ↓

Lettuce Seed Germination Responds to Light



Blue light

↓

Far red light

- Inhibits germination (deep under the ground or under crops)
- Stimulates elongation (in shadow of other plants)

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Van Ieperen et al. 2010

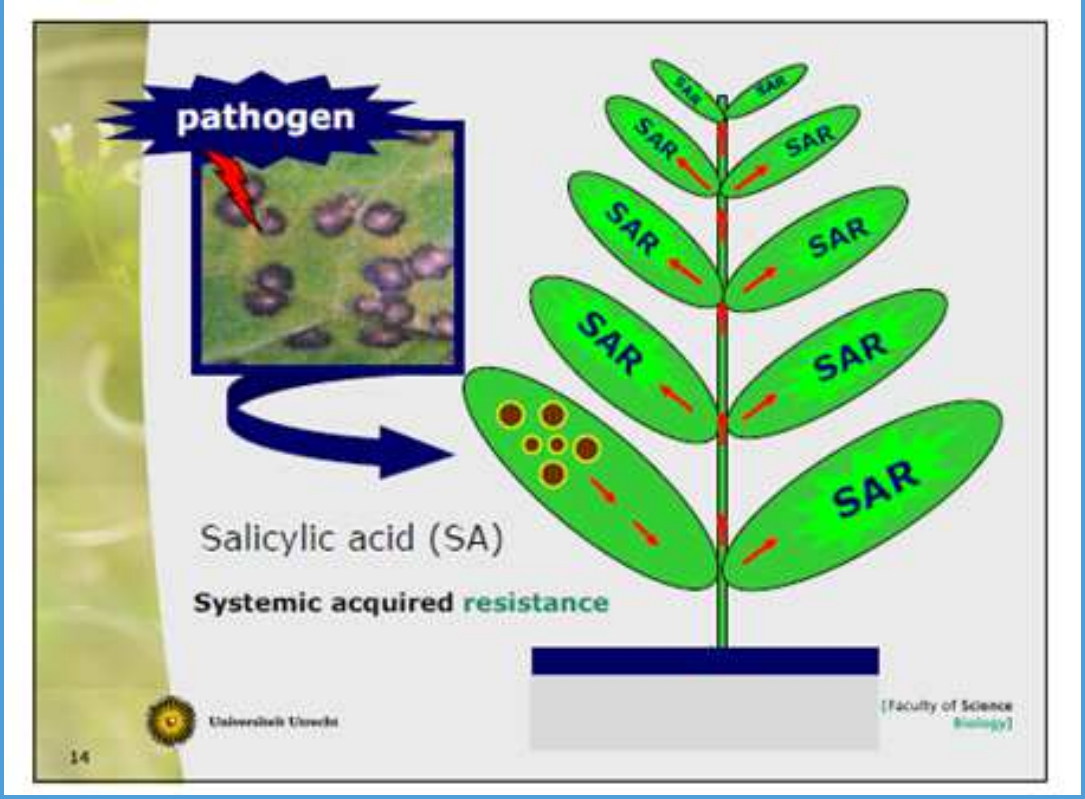
Light quality influences...

		Wave length (nm)	Plant response
PAR	Blue	400-500	- Stimulates stomatal opening, photosynthesis, leaf thickness - Inhibits elongation
	Green	500-600	- Stimulates photosynthesis - Is most reflected
	Red	600-700	- Stimulates chlorophyll synthesis, auxillary shoot growth, leaf thickness, photosynthesis, germination, secundary metabolites - Inhibits elongation - Induces flowering (LDP) - Influences photoperiodism

Light quality influences...

	Radiation	Wave length (nm)	Plant response
UV	UV C	0-280	<300nm does not reach earth
	UV B	280-320	- Stimulates secundary metabolites
	UV A	320-400	- Stimulates hardening
NIR	Far red	700-800	- Stimulates elongation, leaf area - Inhibits auxillary shoots, germination, flowering in LDP
	Near infrared	800-3000	Only heat radiation

Local leaf reaction ➡ systemic resistence



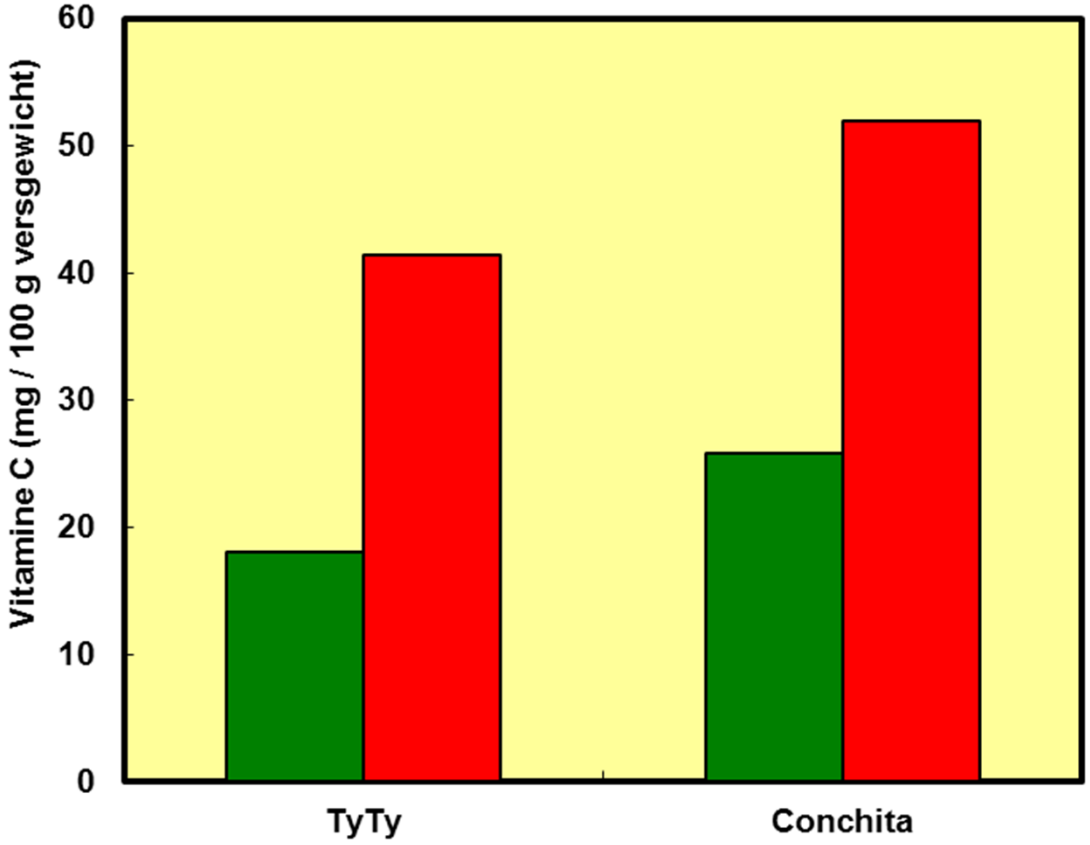
- Biotrophic organisms: mildew, bacteria, virusses.
- Salicylic acid -> (SAR)
- Also effects of light or P-fertilizers, amino acids.

Hofland et al. 2012-2103

Use of steer light: quality and tomato

LED light on trusses increases vitamin C

Supplementary LED light
Increases vitamin C content in tomato



Driever & Verkerke 2010

Intensive colouring by UV

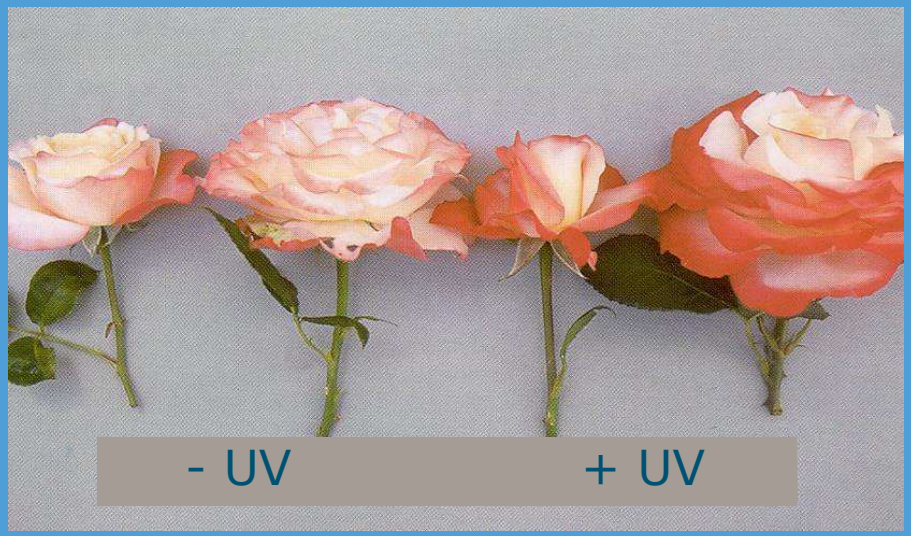
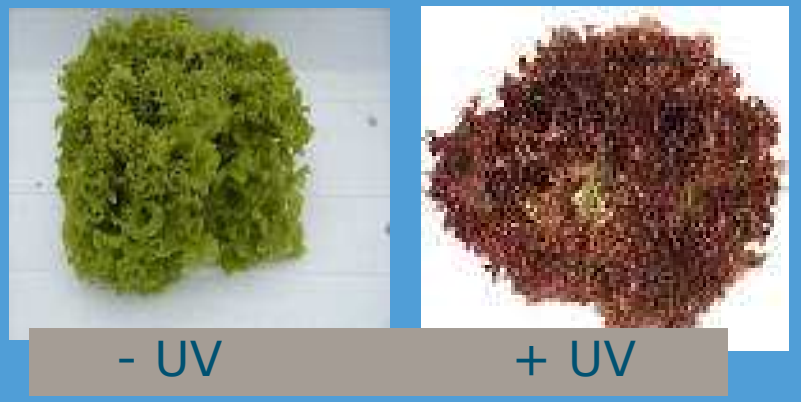


Foto: onderzoek Beßler, LVG Ahlem



Hemming et al. 2006

Innovation Demonstration Centre LED

Wageningen UR Glastuinbouw

Thanks for your attention

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