

Advanced greenhouse horticulture contribution to Bio-regenerative Life Systems in Space

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Wageningen University & Research Centre

Science Groups:

Core activities:

- Research
- Education
- Knowledge transfer



Plant Science: Our research themes



Sustainable production & materials climate change Plant-based materials Health Systems biology



Wageningen UR Greenhouse Horticulture

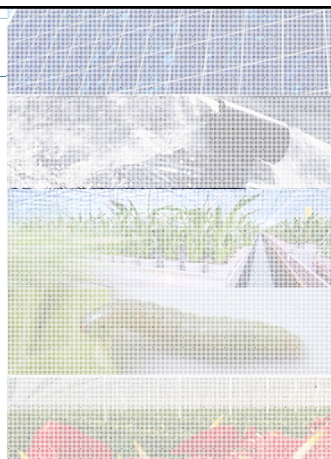
- Some 100 scientists dealing with all aspects of greenhouse production
- Proud to be the largest concentration of greenhouse specialists in the world



Fields of expertise:

- Sustainable crop protection
- Innovative cropping systems
- Quality of crop and product
- Climate and energy
- Water use and emission

...applied at home, abroad and in space: EDEN-ISS



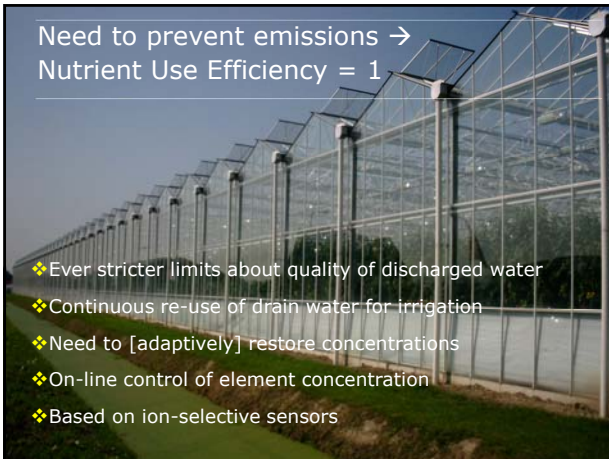
Some issues common to BLS systems in space and commercial greenhouse production

- High water & nutrient use efficiency
 - Root-zone system, fert-irrigation recipes
- Steering of plant processes towards efficient production
 - Use of "steering" variables: light, temperature, CO₂,...
- Timely detection of [a]biotic stress
 - Plant monitoring and its interpretation
- Selection of resource-efficient crops/varieties
 - Light; electricity; space; labour; water...



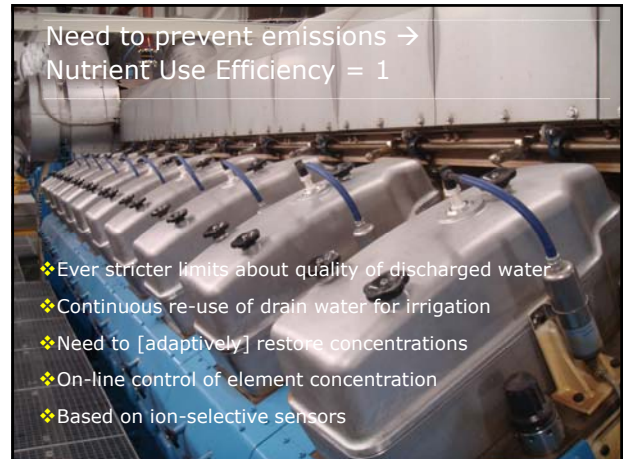
Need to prevent emissions →
Nutrient Use Efficiency = 1

- ❖ Ever stricter limits about quality of discharged water
- ❖ Continuous re-use of drain water for irrigation
- ❖ Need to [adaptively] restore concentrations
- ❖ On-line control of element concentration
- ❖ Based on ion-selective sensors




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Steering of plant processes through light


- Light intensity x duration
 - Photosynthesis
 - ◆ **Biomass**
- Light spectrum
 - Plant elongation
 - Shoot formation
 - Plant resilience
 - Leaf transpiration
 - Germination & flower induction
 - Quality



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For quality of life

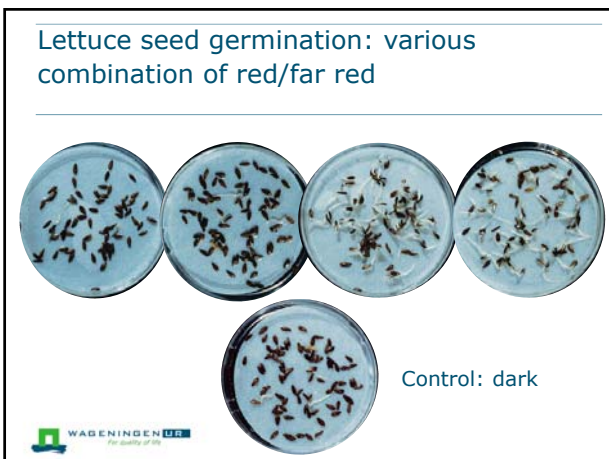
Stem elongation and shoot formation

Red/Far red ratio



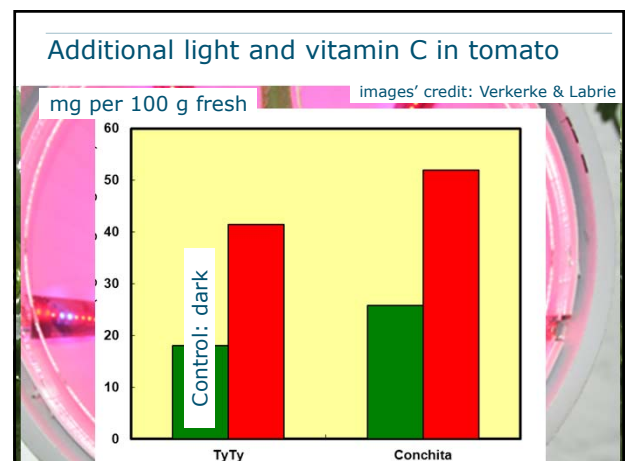
images' credit: Heuvelink & van Ieperen

Lettuce seed germination: various combination of red/far red



Control: dark

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For quality of life



Plants' need for a dark period limits the use[fulness] of artificial light

- A single gene is responsible for the need of at least six hours dark of all commercial tomato varieties
- This is the result of a [PhD] research co-financed by the Dutch ministry of Education and a breeding company
- The "tomato that never sleeps" is within reach



Monitoring crop performance:



CropObserver™
with multiple
spot
measurement

CropObserver™ in a tomato greenhouse



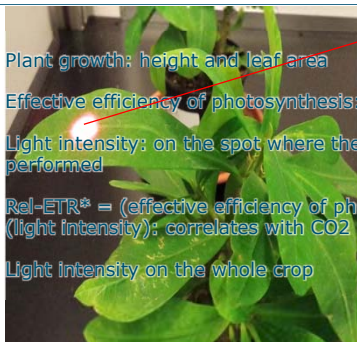
CropObserver™ in a tomato greenhouse



- Mapping of chlorophyll-containing positions
- A user-defined protocol scans and measures all positions
- This protocol is repeated until next mapping

Measurements at each position:

- Plant growth: height and leaf area
- Effective efficiency of photosynthesis: $\Phi_{PSII} = F_q' / F_m'$
- Light intensity: on the spot where the measurement is performed
- $Rel-ETR^* = (\text{effective efficiency of photosynthesis}) \times (\text{light intensity})$: correlates with CO₂ uptake → growth
- Light intensity on the whole crop



Conclusions

- High resource use efficiency (space, light, electricity, water, labour) is essential to both commercial greenhouse production and to BLSS
- Relevant knowledge and tools have been/are being developed for greenhouse production that can be useful for BLSS
- We don't start from scratch, but there is an obvious need for adaptation

