

Dimensioning and planning crop production in a simulated space expedition

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Background EDEN-ISS project

Aim: Growing fresh food for future space missions

Designing growing recipes:

- to produce tasty 'ready-to-eat' fresh food
- with limiting factors (space, light, temperature, energy)

Context EDEN-ISS

Space missions: future



'Earthy' test: Antarctica: 2018



Tasks Wageningen:

- Tests for designing growing recipes
- Training space engineer
- Remote plant health monitoring



Future exploration greenhouse



Tests growing recipes (Wageningen)

- Selection crops
- Maximize fresh food production
- Determine resource requirements
- Continuous production by careful planning of seeding and harvesting
- Growing handbook: cultivation recipes



Selected crops

- Lettuce: crispy, red romaine, batavia
- Leafy greens: Swiss chard, red mustard, rocket, spinach
- Radish
- Herbs: parsley, chives
- Fruit vegetables: tomato, cucumber, pepper



Climate chambers in Wageningen

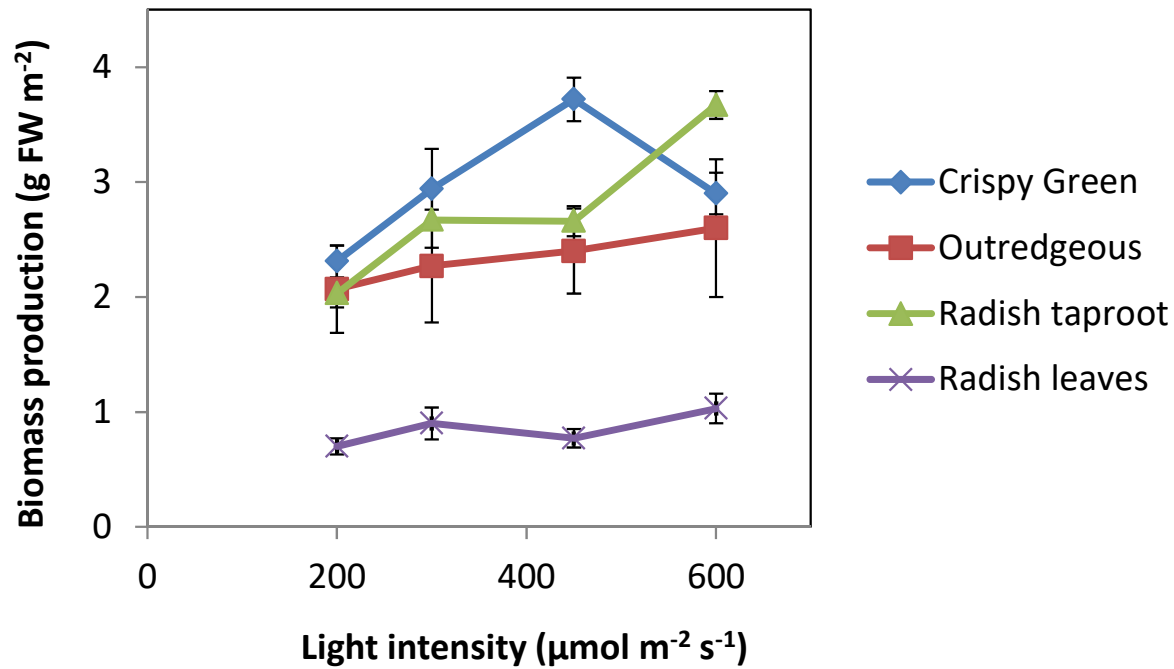


Experiments

- 4 light intensities (200, 300, 450, 600 $\mu\text{mol m}^{-2} \text{s}^{-1}$)
- 2 temperatures: 21/19° and 25/23°C (day/night)
- Space use efficiency: single and spread harvest



Effect of light intensity



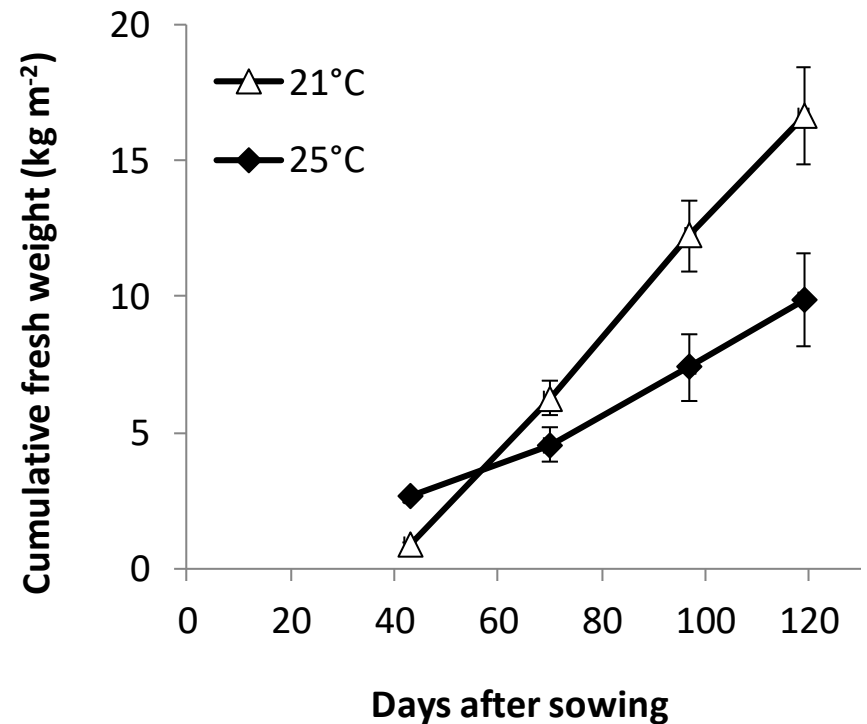
Effect of light intensity: quality



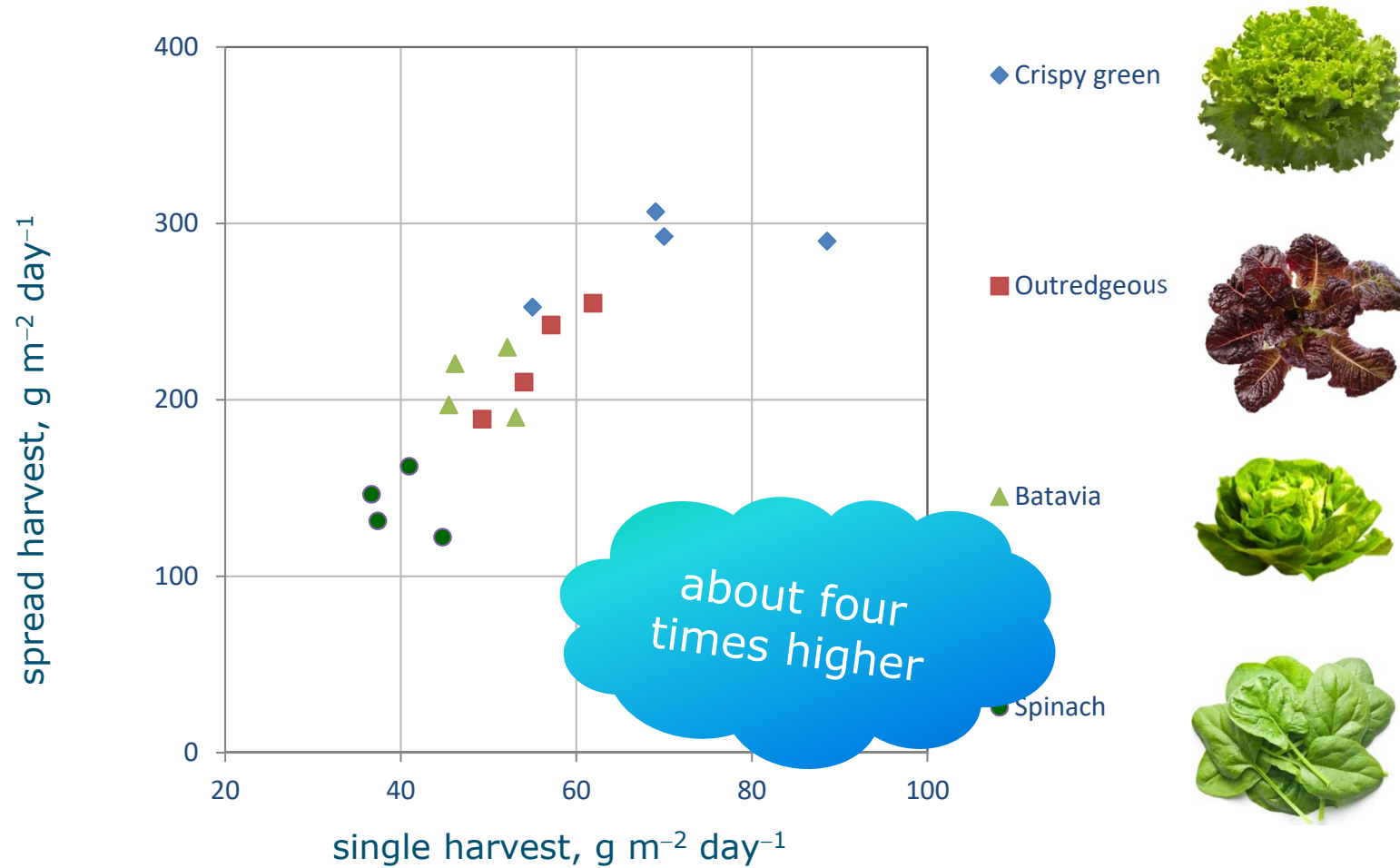
Effects of temperature (21 and 25°C)

- 25°C increased production of some crops (red mustard, rocket, chives)
- 25°C decreased production of radish
- Herbs: poor regrowth at 25°C

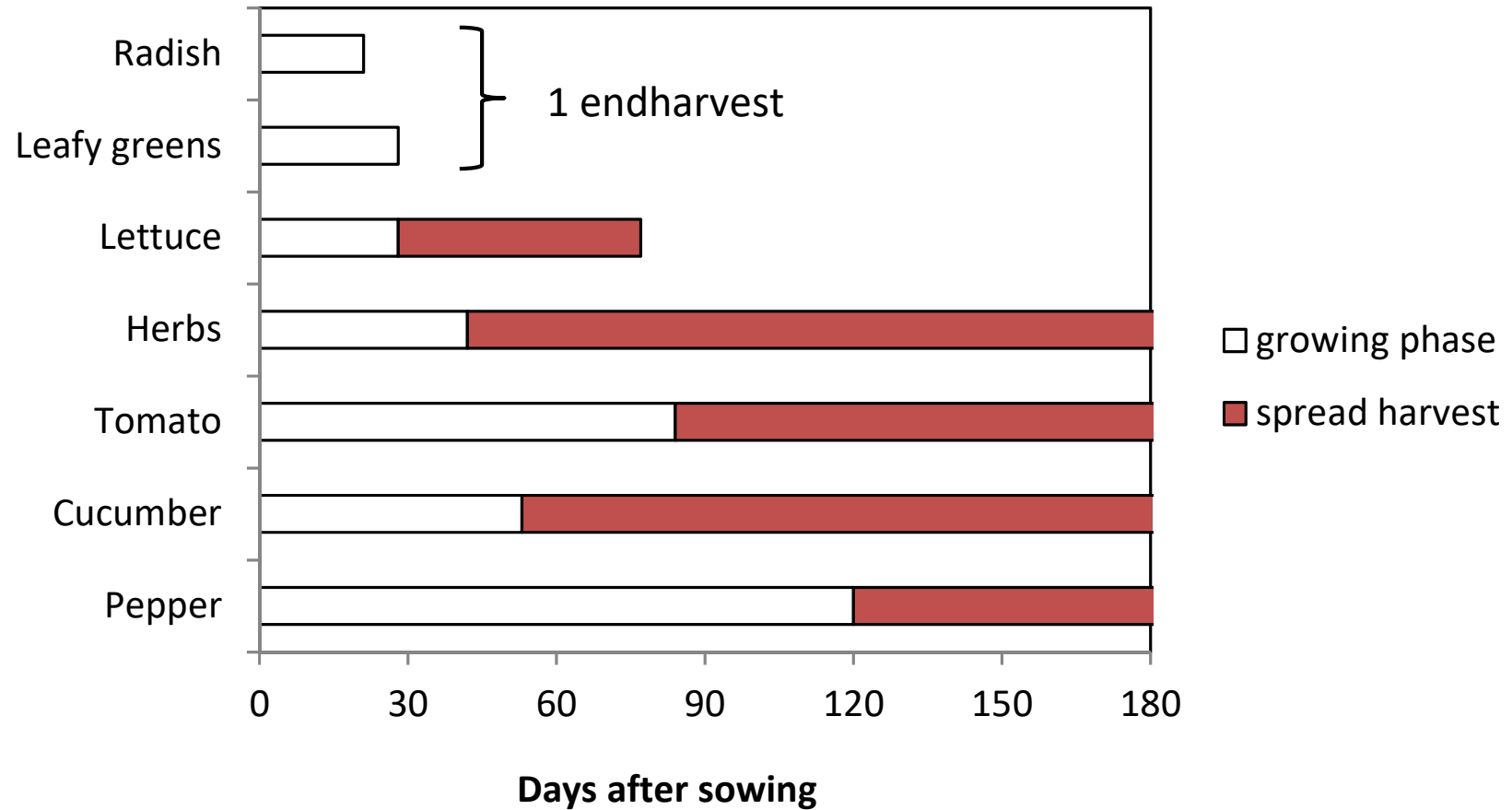
Parsley



Space use efficiency



Cultivation scheme per crop



Production per week

| Crop | FW (kg week ⁻¹ tray ⁻¹) | Trays | Plants tray ⁻¹ | Weekly FW (kg) |
|------------------|--|-----------|---------------------------|-------------------|
| Lettuce (spread) | 1.0 | 2 | 20 | 2.0 |
| Tomato | 0.4 | 4 | 4 | 1.5 |
| Cucumber | 0.6 | 5 | 2 | 2.9 |
| Radish | 1.0 | 1 | 66 | 1.0 |
| Leafy greens | 0.2 | 7 | 40 - 150 | 1.7 |
| Herbs | 0.3 | 2 | 150 - 450 | 0.6 |
| Total | | 21 | | 9.7 |

Final advice cultivation recipe

- Cultivation at 21/19°C and 300 $\mu\text{mol m}^{-2} \text{s}^{-1}$
- Radish and chives at 600 $\mu\text{mol m}^{-2} \text{s}^{-1}$
- CO₂ 750 ppm
- Spread harvest for lettuce increases production (4 times)
- Fresh production per week: max 10 kg

Results Antarctic until 1 May 2018

- Sowing 7 February
- First harvest 14 March: lettuce (single harvest)
- 42 kg edible fresh food (< 6 weeks full production)
- Cucumber (17 kg), lettuce (10 kg), leafy greens, radish, herbs

Good work
Paul!



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