

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)



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Context EDEN-ISS

Space missions: future

'Earthy' test: Antarctica: 2018

Tasks Wageningen:

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



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Future exploration greenhouse



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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



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Selected crops

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



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Climate chambers in Wageningen

1 m 50 cm

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

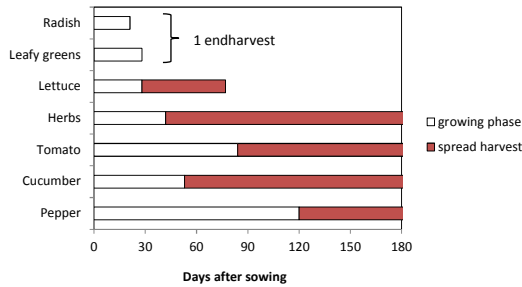
Effects of temperature (21 and 25°C)

- 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 μmol m⁻² s⁻¹
- Radish and chives at 600 μmol m⁻² 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!



Thanks to...

- The EU-H2020 grant
- The Dutch Ministry of Agriculture, Nature and Food Quality
- ...and you all for your attention



Growth conditions

- Temperature: 21/19°C and 25/23°C day/night
- CO₂ concentration: 700-800 ppm
- Light intensity: 200-600 μmol m⁻² s⁻¹
- Light spectrum: red/white/blue/far red
- Daily light scheme: simulate dawn/dusk

