Agronomic performances of tomato and winter vegetables in the Danish trial

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Final project Meeting
Rome, 21/09/2021
Experimental site Denmark - BAU

Fodder radish
Sown 09-09-2018
Harvest 20-12-2018

Bare soil
20-12-2018 until 22-03-2019

Tomato
Planted 22-03-2019

Bare soil rep 1 rep 2 rep 3
Experimental site Denmark - INN

Fodder radish
Sown 09-09-2018
Harvest 07-11-2018

WLC
Sown 16-11-2018
Harvest 12-03-2019

Lettuce
Sown 01-02-2019
Planted 22-02-2019
Harvest 24-04-2019

Tomato/snap pea
Planted 01-05-2019
Sown 22-05-2019

Flower strip
rep 1
rep 2
rep 3
LWC1
LWC2
LWC3
LWC1
LWC2
LWC3
LWC1
LWC2
LWC3
Tomato 2019/2020 – Yield and energy for heating

Accumulated yield (ton ha⁻¹)

<table>
<thead>
<tr>
<th>System</th>
<th>Harvest period</th>
<th>Total yield (kg m⁻²)</th>
<th>Energy use (kWh m⁻²)</th>
<th>Harvest period</th>
<th>Yield (kg m⁻²)</th>
<th>Energy use (kWh m⁻²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BAU</td>
<td>11 Jun – 04 Nov</td>
<td>41.96</td>
<td>301</td>
<td>20 Ap – 28 Sep</td>
<td>29.3</td>
<td>498</td>
</tr>
<tr>
<td>INN</td>
<td>18 July – 03 Oct</td>
<td>25.82</td>
<td>0</td>
<td>02 July – 05 Oct</td>
<td>20.5</td>
<td>0</td>
</tr>
<tr>
<td>INN2</td>
<td>15 July – 03 Oct</td>
<td>24.99</td>
<td>0</td>
<td>02 July – 05 Oct</td>
<td>24.0</td>
<td>0</td>
</tr>
</tbody>
</table>

INN2 from ClimateVeg project

www.greenresilient.net
Yields - Denmark

<table>
<thead>
<tr>
<th>System</th>
<th>Crop</th>
<th>(Saleable) yield (ton ha(^{-1}))*</th>
<th>Head size (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>INN</td>
<td>Fodder radish</td>
<td>17.02±0.78</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Winter purslane</td>
<td>1.87±0.52</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lettuce</td>
<td>21.05±134</td>
<td>198.1±13.6</td>
</tr>
<tr>
<td>BAU</td>
<td>Fodder radish</td>
<td>22.87±2.66</td>
<td></td>
</tr>
</tbody>
</table>

* Netto production area 2/3 of total area

WLC’s evaluation

**Mizuna** – did not germinate, soil temperature too low in November? The ones that germinated developed well in spring

**Mangold** – only few plantlets survived, too small for over-wintering

**Winter purslane** – Only one harvest, could have taken more and postponed the crop of lettuce

In 2019/2020 – Earlier sowing/planting if possible or planting of bigger plantlets. Other crops (spinach sown late autumn)
THREE ORGANIC GREENHOUSE SYSTEMS ARE COMPARED

• Business as usual (BAU) – heating according to traditional tomato crop
• Innovative system 1 (INN) – heating below 4 °C and venting at 20 °C
• Innovative system 2 (INN2) - heating below 8 °C and venting at 20 °C

Winter 2019/2020

• BAU – one long tomato crop, no winter leafy crop (WLC)
• INN – summer crop of tomato + two short WLCs (Greenresileint)
• INN2 – summer crop of tomato + one long WLC crop (ClimateVeg)
### INN – Brown mustard followed by pointed cabbage

<table>
<thead>
<tr>
<th>Sown:</th>
<th>10 October</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harvested:</td>
<td>17 February</td>
</tr>
<tr>
<td>Terminated:</td>
<td>05 March</td>
</tr>
<tr>
<td>Yield:</td>
<td>Between 0.5 and 5 tons per ha</td>
</tr>
<tr>
<td>Cultivar:</td>
<td>Moutarde rouge metis</td>
</tr>
<tr>
<td>Comment:</td>
<td>Germination very uneven - sow earlier or plant out; not so suitable for multiple harvests</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sown:</th>
<th>07 February</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planted:</td>
<td>05 March</td>
</tr>
<tr>
<td>Harvested:</td>
<td>28 April</td>
</tr>
<tr>
<td>Yield:</td>
<td>254 g per head without trimming</td>
</tr>
<tr>
<td>Cultivar:</td>
<td>Eersteling</td>
</tr>
<tr>
<td>Comment:</td>
<td>Too small - planting early February necessary</td>
</tr>
</tbody>
</table>
INN – Lettuce followed by celtuce

**Sown:** 19 September  
**Planted:** 10 October  
**Harvested:** 18 December  
**Yield:**  
**Cultivar:** Olmetie  
**Comment:** Looked very well until early December. Very few saleable heads at harvest due to grey mould.

**Sown:** 03 January  
**Planted:** 31 January  
**Harvested:** 16 April  
**Yield:** 137 g per plant without trimmings  
**Cultivar:**  
**Comment:** Grew very well, but needs long days for proper stem elongation (flowering)
INN – spinach followed by lettuce

Sown: 10 October 2019
Planted:
Harvested: 12 March 2020
Yield: 4.4 ton per ha
Cultivar: 30177
Comment: Did not germinate very well. Better to plant out. Cultivar with bigger leaves such as ‘Nores’.

Sown: ?
Planted: 12 March 2020
Harvested: 28 April
Yield: 95 g per head
Cultivar: Lollo rosso
Comment: Very small. Grey mould.
CONCLUSIONS

• It is a bit of a compromise to start WLCs early enough for a good establishment and harvesting the last tomatoes. Our tomato crop was terminated 03 October and WLCs sown or planted 10 October.

• Most crops were better sown in plugs and planted out as conditions in autumn were inappropriate for good germination and seedling establishment. A few crops like Mizuna, brown mustard and winter purslane can be sown if a good seedbed is prepared.

• Under Danish conditions light is the limiting factor and plants are hardly growing from end-November until mid-February. The winter 2019/2020 was mild with only few hours of sun. Alternative: supplemental LED!

• Promising alternative WLCs to Asian greens/winter purslane/lettuce are peas, spinach (if a large leaved cultivar is chosen), celtuce (if night interruption is introduced) + pointed cabbage.

• The difference in tomato yields between INN2 and BAU decreased in the second year due to diseases for plants in the BAU system