Weed control in organic crop rotations for grain production

Ilse A. Rasmussen
Jørgen E. Olesen
Margrethe Askegaard
Weed control in organic crop rotations for cereal production

- Crop rotations
- Weed control
- Results & discussion
Crop rotations

- Organic crop rotations
- for cereal production

- Problems:
  - yield
  - weeds
  - others
Crop rotations

• 4 different crop rotations

• 4 locations in Denmark
  - different soil types
  - different climates
  - different weed flora
Crop rotations

Three-factorial experiment:
• fraction of legumes in the rotation (crop rotation)
• catch crop (with or without)
• manure (with or without slurry)
Crop rotations

Decreasing fraction of legumes:
Rot. 1: 1.5 grass-clover + 1 pulse crop
Rot. 2: 1 grass-clover + 1 pulse crop
Rot. 3: 1 grass-clover
Rot. 4: 1 pulse crop
Crop rotations

• Rotation 2
  - Spring barley with undersown ley
  - Grass-clover ley
  - Winter wheat
  - Pea/barley
Crop rotations

• Rotation 2 with catch crops
  - Spring barley with undersown ley
  - Grass-clover ley
  - Winter wheat with ryegrass
  - Pea/barley with ryegrass and clover
Crop rotations

• Rotation 4 with catch crops
  - Oats with undersown clover
  - Winter wheat/clover
  - Winter wheat/clover
  - Pea/barley with ryegrass and clover
Crop rotations

Years with different crop types

<table>
<thead>
<tr>
<th>Rot.</th>
<th>Ley</th>
<th>Pulse</th>
<th>Cereal</th>
<th>Row crop</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.5</td>
<td>1</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>0</td>
<td>1</td>
<td>3</td>
<td>0</td>
</tr>
</tbody>
</table>
Crop rotations

With manure:

- 40% of nitrogen demand of the rotation applied as slurry

All straw and other plant residue left on the soil

Clover-grass is cut several times and left on the soil
### Crop rotations

**Manure application:**

<table>
<thead>
<tr>
<th>Crop (rotation)</th>
<th>kg N ha(^{-1})</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spring barley (1, 2 &amp; 3)</td>
<td>50</td>
</tr>
<tr>
<td>Oats (4)</td>
<td>40</td>
</tr>
<tr>
<td>Spring wheat (1)</td>
<td>50</td>
</tr>
<tr>
<td>Winter wheat (2 &amp; 3)</td>
<td>50</td>
</tr>
<tr>
<td>Winter wheat (4)</td>
<td>70</td>
</tr>
<tr>
<td>Sugar beets (3)</td>
<td>50</td>
</tr>
</tbody>
</table>
Crop rotations

- 2 replicates (blocks)
- each block with 2 subblocks
- in each subblock 2 combinations of each crop rotation
Plot infrastructure at Flakkebjerg
Weed control

Prevention

- Cultivars which are competitive
- Late sowing of winter cereals
- Placing manure close to crops
- Crop density
Weed control

Optimal mechanical weed control

• Spring sown cereals and pulses without catch crops:
  - pre-emergence harrowing
  - post-emergence harrowing
  - supplementary harrowing later if needed
Weed control

• Winter cereals with and without catch crops:
  - pre-emergence harrowing if possible
  - post-emergence harrowing if possible
  - harrowing early spring

• without catch crops:
  - supplementary harrowing later if needed
Weed control

• Winter wheat at Jyndevad and winter cereals in rotation 4 without catch crops at Fouulum since 1998:
  - sown at larger than normal row distance
  - mechanical hoeing between rows
  - supplementary harrowing
Weed control

• Winter cereals in rotation 4 with catch crops:
  - brush hoeing between rows 2-3 times
Weed control

• Sugar beets:
  - pre-emergence flame weeding
  - hand hoeing in the rows
  - mechanical hoeing between rows
  - hand weeding
Weed control - perennials

- **Couch grass:**
  - without catch crops - stubble cultivation at more than 5 shoots m\(^{-2}\)
  - with catch crops - stubble cultivation at more than 50 shoots m\(^{-2}\)
  - cutting the grass-clover more often at more than 5 shoots m\(^{-2}\) in the preceding crop
Weed control - perennials

- **Couch grass thresholds:**
  - stubble cultivation:
    - without catch crops > 5 shoots m\(^{-2}\)
    - with catch crops > 50 shoots m\(^{-2}\)
  - cutting the grass-clover more often at more than 5 shoots m\(^{-2}\) in the preceding crop
Weed control - perennials

• **Creeping thistles:**
  - cut below ground and pulled at the anthesis of the cereals

• **Others (mugwort, curled dock etc.):**
  - pulled up at sight

• **Stubble cultivation in systems without catch crops**
Results

• Few significant differences

• Many interesting tendencies

• Only two years results
Weeds at 4 locations 2 years

![Bar chart showing weed counts at four locations (Jyndevad, Foulum, Flakkebjerg, Holeby) over two years (1997 and 1998). The chart displays the number of weeds per square meter (Number m⁻²) and the weight of weeds per square meter (g m⁻²).]
Weeds in different crops at Foulum

Pea:barley
Spring barley
Oats
Winter wheat

1997
1998

0
10
20
30

gm⁻²
Effect of manure on weeds in winter wheat

![Graph showing the effect of manure on weeds in winter wheat. The graph compares different areas and years (Foulum 97, Foulum 98, Flakkebjerg 97, Flakkebjerg 98, Jyndevad 97, Jyndevad 98) with and without manure. The y-axis represents grams per square meter (g m²) ranging from 0 to 50. The x-axis lists the areas and years. There are asterisks indicating statistical significance.](image)
Effect of manure on weeds and wheat

- Jyndevad 97
- Jyndevad 98
- Foulum 97
- Foulum 98
- Flakkebjerg 97
- Flakkebjerg 98

**Y-axis:** g m$^{-2}$

- **Wheat, no manure**
- **Wheat + manure**
- **Weeds**
Effect of weed control in winter wheat 1998

- Weed harrowing
- Weed harrowing + supplementary
- Row hoeing
- Brush weeding

The graph shows the comparison of weed control methods at three locations: Foulum, Flakkebjerg, and Jyndevad. The methods are indicated by different colors, and the graph displays the amount of weed control achieved in grams per square meter (g m⁻²). The locations are compared with different symbols indicating significant differences in weed control effectiveness.
Effect of weed harrowing in oats

![Bar chart showing the effect of weed harrowing in oats.](image-url)
Effect of weed harrowing in oats

<table>
<thead>
<tr>
<th>Location</th>
<th>1997</th>
<th>1998</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weed harrowing</td>
<td>3.5</td>
<td>5.2</td>
</tr>
<tr>
<td>No weed harrowing</td>
<td>2.8</td>
<td>3.7</td>
</tr>
</tbody>
</table>

Yield, tons ha⁻¹
Percentage of plots with couch grass

- Jyndevad: Spring sown: 40%, Autumn sown: 50%
- Flakkebjerg: Spring sown: 10%, Autumn sown: 40%
- Holeby: Spring sown: 20%, Autumn sown: 50%
Effect of catch crop on creeping thistle 1998

Number of plots with thistles

With catch crop

Without catch crop

Anthesis
Harvest

0 2 4 6 8 10 12 14
Effect of previous crop on creeping thistle in wheat 1999

Number m$^{-2}$

Fresh weight

Grass clover ley Cereals

Number Fresh weight
Effect of previous crop and catch crop on creeping thistle in wheat 1999

![Bar graph showing the effect of previous crop and catch crop on creeping thistle in wheat 1999. The graph compares the number of creeping thistles per square meter between no catch crop and catch crop treatments for cereals and grass clover ley.]
Summary

• Most weeds on lighter soils
• Most weeds in winter wheat
• Most weeds with manure
• Good effect of row hoeing in winter wheat
• Good effect on weeds of weed harrowing in oats – no effect on yield
Summary

• Most weeds on lighter soils
• Most weeds in winter wheat
• Most weeds with manure
• Good effect of row hoeing in winter wheat
• Good effect on weeds of weed harrowing in oats
Summary

- Most couch grass in winter sown cereals
- Most creeping thistle without catch crop
- Most creeping thistle with cereals as previous crop
Summary

• Most creeping thistle without catch crop
• Most creeping thistle with cereals as previous crop
References

References
