Impact, management and control of clubroot disease in the UK

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Leading the way in Agriculture and Rural Research, Education and Consulting
Introduction:

• Oilseed rape (canola) is one of UK’s most profitable crops (2\textsuperscript{nd} only to wheat)
• Equally useful as a break crop in rotations
• Scotland's most common break crop
• Clubroot a major issue
• Available control measures incomplete
UK oilseed rape distribution

2015 2016 2017

OSR yields – 3 to 4 t/ha
3.6 t/ha (64 bushels/acre) =
gross margin £667/ha or >$400/acre)
Clubroot a major issue in UK soils


- 96 sites
- Chinese cabbage bioassay used
- Agronomists / consultants used so a probable bias towards fields of concern
- 52% samples positive

- UK strategy of testing and rejecting infected fields is unsustainable as clean land is a diminishing resource
Significant yield losses

Losses can be 100% where crop is abandoned and ploughed back in

Correlation between yield and clubroot severity across all varieties and sites showing a 0.03 t/ha loss per each 1% increase in disease severity (3 year project across 6 trial sites)

\[ y = -0.0294x + 3.8457 \]

\[ R^2 = 0.2225 \]
Poor rotational practices have exacerbated the problem - knowledge on optimal long term rotations required.

After Wallenhammer (1996) showing the clubroot severity in fields following the previous crop of oilseed rape, with crop yield overlaid assuming losses of 0.03 t/ha per % severity of clubroot in a 4 t/ha crop.

1 in 3 rotation = 63 % potential yield
1 in 4 rotation = 65 % potential yield
1 in 5 rotation = 74% potential yield
1 in 8 rotation = 80 % potential yield
Efficacy of management options incomplete

Field trials across 6 UK sites

AHDB project RD-2007-3373

Shropshire field trial site showing susceptible Kommando plot foreground and resistant Mendel in the background, spring 2008.

2 cultivars - Mendel (resistant), Kommando (susceptible)

8 Soil treatments – CaCO$_4$, CaCN$_2$, boron
Clubroot control
– predicated means in cross site analysis (6 sites)
Yield t/ha after soil treatment

- predicated means in cross site analysis (6 sites)
Limited varietal resistance to clubroot

- Heavy reliance by growers on single mechanism
Varietal control – mean clubroot disease severity (% – December)

Note poor efficacy at Aberdeen site where it has been deployed previously.

Kommando susceptible, Mendel and Cracker carry resistance.
Yield by site t/ha

Kommando susceptible, Mendel and Cracker carry resistance
Prevalence and distribution of resistance breaking strains present in UK

AHDB project RD-2140027105

- Soil sampled from 90 commercial clubroot infected fields across the UK
- Soils tested for presence/absence of Mendel virulence
- Soils tested for pH
- Sub-sample of 30 soils tested against ECD set for pathotype determination
- Soil and cropping details collected for each field
Mendel resistance breaking strains
– common throughout UK

Clubroot severity in resistant as a % severity in susceptible

2016

2017
Preliminary pathotyping (ECD) - shows that clubroot in the UK is highly diverse.

<table>
<thead>
<tr>
<th>2016 Field</th>
<th>Dominant pathotypes defined by ECD</th>
<th>2017 Field</th>
<th>Dominant pathotypes defined by ECD</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>16/02/30</td>
<td>11</td>
<td>16/31/31</td>
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<tr>
<td>2</td>
<td>16/26/04</td>
<td>12</td>
<td>17/31/30</td>
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<td>3</td>
<td>16/15/31</td>
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<td>16/15/30</td>
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<td>5</td>
<td>17/31/31</td>
<td>15</td>
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<td>17/31/30</td>
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<td>17/31/30</td>
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<tr>
<td>10</td>
<td>23/31/31</td>
<td>20</td>
<td>0/6/0</td>
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</tbody>
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Field testing

- Soil testing allows both short and long term planning
- Clean soil is a diminishing resource
- Some practices not sustainable
- More detailed field mapping could facilitate targeted application of available control measures

AHDB project RD-2140027105

Comparison of primers from Faggian and Parsons (2002) and Wallenhammar et al. (2012)
Field mapping using soil tests, UAVs and yield maps

Top: Little Dilwyn, England. Bottom: Backboath, Scotland

<table>
<thead>
<tr>
<th>Clubroot severity (0-100 index)</th>
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<tbody>
<tr>
<td>0</td>
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<td>10</td>
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<td>100</td>
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</tbody>
</table>

AHDB project RD-2140027105
Mapping can help to quantify economic losses and aid decision making.

<table>
<thead>
<tr>
<th>2016 Market field (t/ha)</th>
<th>2016 Podge field (t/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.806 1.9236 1.748 3.806</td>
<td>3.7 3.7 3.7 3.406 3.406 3.7</td>
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<tr>
<td>3.806 2.336 1.748 3.806 3.806</td>
<td>3.406 3.7 1.936 3.7 3.112</td>
</tr>
<tr>
<td>3.806 2.336 2.924 3.806</td>
<td>3.112 3.112 2.818 3.406</td>
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Novel control methods?  
Elicitor application – seed soak

Replicated pot experiments following on from earlier work on soil drenches and foliar sprays
Field trials - seed soaks
– results show elicitors give variable control

![March 2017 Clubroot elicitor trial graph]

Seed soaks in replicated field trial  Scottish Government RESAS SRP RD2.1.6
Summary

- Soil amendments that raise soil pH and calcium content only partially reduce disease severity.
- Varietal resistance gives good control at many sites but is often poor at sites where resistant varieties have been commonly used in previous rotations.
- Mendel breaking strains are present throughout the UK.
- Alternative control measures such as elicitors have some potential.
- Targeted application of such measures (through field mapping) might help.
Current UK advice

- Test soils for clubroot and pH and use results to plan strategy for farm.
- Pay attention to hygiene and soil movement.
- Rotations of greater than 1 year in 5 are likely to be beneficial.
- Avoid early sowing on infected sites
- Avoid over-reliance on resistant varieties in short rotations
- Only deploy resistant varieties where justified by disease level to avoid over use and selection of virulent strains
- Maintain high pHs on infected sites and use long rotations.
- Spot treat infected patches in fields with lime
Future needs

• Improve methods for early (cheap) detection and prevention of clubroot
• Expand the range of tools for integrated and sustainable disease management (resistance, tolerance, escape, bio-control, elicitors)
• Develop robust economic models to deploy tools sustainably and to help industry resolve conflict between short term profitability and long term sustainability
Thank you!

Plus acknowledgements to staff teams at ADAS and SRUC