An Integrated Pest management Strategy for pollen beetle in oilseed rape: Are we nearly there yet?

Sam Cook
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Integrated Pest Management (IPM) for pollen beetle in oilseed rape

To B(rassicogethes), or not to B(rassicogethes): that’s the question;

Whether 'tis nobler in the mind to suffer the slings and arrows of outrageous fortune, Or to take arms against a sea of troubles, And by opposing end them? (Hamlet)

Should we accept this or fight it?

Who cares?
"A rose by any other name would smell as sweet’ (Romeo & Juliet)

This is unnecessary over splitting of the genus and will lead to confusion (and Romeo & Juliet didn’t end well!)

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The name change has not been accepted by National Biodiversity network NHM (UK) BUT term becoming more widely accepted (EPPO included).

So, do I have to accept this? Do we accept this??

If so then I’m extremely sad to announce the demise of *Meligethes aeneus* – but perhaps we’ll have more luck controlling *Brassiocogethes aeneus*?!

William Shakespeare, 1564 - 1616

Meligethes aeneus (Fabricius 1755) Stephens 1830- 2016

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Integrated Pest Management (IPM)

• IPM is an effective and environmentally sensitive approach to pest management that relies on a combination practices (including the judicious use of pesticides)

• 4 usual steps in IPM programmes:
  1. Set action threshold
  2. Monitor pest density & assess risk
  3. Prevention – cultural methods e.g. crop rotation, use of pest-resistant cultivars, semiochemical e.g. pheromone repellents, habitat diversification intercropping, trap cropping
  4. Control – mechanical (e.g. trapping), biological, conservation biocontrol, botanical insecticides, synthetic pesticides
Pollen beetle (*Brassicogethes* / *Meligethes aeneus*)

**Life Cycle:** univoltine
Pollen beetle (*Brassicogethes* / *Meligethes aeneus*)

**Damage**

- Adult feeding damage at bud stage causes abscission ‘blind stalks’

 Untreated vs. treated
Pollen beetle (*Meligethes aeneus*)

**Damage**

- Adult feeding damage at bud stage causes abscission ‘blind stalks’
- Pyrethroid resistance widespread across Europe
- Loss of control resulted in complete loss of 30,000ha (€22-25 M) in Germany 2006
- Indoxacarb, neonicotinoids (thiacloprid acetamiprid) & Pymetrozine currently viable alternatives
1. Set Action Thresholds

E.g. Reevaluation of threshold for pollen beetle (UK)
AHDB Project 495 (Ellis & Berry, 2014)

Previous to 2012 UK threshold 15 beetles/plant or 5 for backward crops (GS 50-61)
- Logic: 1) calculate the number of flowers that can be lost by plants to pollen beetles and still produce maximum yield (1 beetle damages 9 buds/season)
- 2) The number of ‘excess flowers’ could be predicted by # plants/m² at the bud stage. Crops with fewer plants/m² had more excess flowers than more dense crops
1. Set Action Thresholds

Threshold for pollen beetle (UK) now based on plant density as well as number of pollen beetles/plant

<table>
<thead>
<tr>
<th>Plant Density</th>
<th>Threshold</th>
</tr>
</thead>
<tbody>
<tr>
<td>less than 30 plants/m²</td>
<td>25 pollen beetles per plant</td>
</tr>
<tr>
<td>30–50 plants/m²</td>
<td>18 pollen beetles per plant</td>
</tr>
<tr>
<td>50–70 plants/m²</td>
<td>11 pollen beetles per plant</td>
</tr>
<tr>
<td>more than 70 plants/m²</td>
<td>7 pollen beetles per plant</td>
</tr>
</tbody>
</table>

Photo © Alan Dewar, Dewar Crop Protection
1. Set action thresholds - Pyrethroid use in UK

Pollen beetle populations are usually below UK spray thresholds (15 beetles/plant) - only rarely reach threshold for backward crops (5 beetles/plant)

Defra data - collected through FERA's CropMonitor project
1. Set action thresholds - Pyrethroid use in UK

...But spring insecticide use is increasing (main target: pollen beetle)!
So thresholds not being used.. Why not?
2. Monitor pest density & assess risk

Advice:

- Crops at risk during green-yellow bud phase
- Risk of immigration on dry days when temperatures > 15 °C
- Pollen beetle spray threshold = 15/plant (average)
- Pest sampling protocol: ‘...10 plants sampled along a 30m transect across the field. Each transect should start at the headland and go diagonally across the field, choosing a plant at random every couple of metres’
2. Monitor pest density & assess risk

- Monitoring procedure is time consuming
- Pollen beetle immigration occurs over 2-6 week period

A baited monitoring trap will help growers & advisers to more easily and more accurately identify when spray thresholds have been breached than by plant scouting methods.
2. Monitor pest density & assess risk

**Monitoring methods**: Developing a monitoring trap for pollen beetle colour

Cook, Skellern, Döring & Pickett (2013) *Arthropod-Plant Interactions* 7:249–258

2. Monitor pest density & assess risk

**Monitoring methods**: *Developing a monitoring trap for pollen beetle*

**Volatile lure**

- Lure derived from OSR host plant volatiles (in the absence of pheromones)
- 15 electrophysiologically active volatiles identified
2. Monitor pest density & assess risk

Monitoring methods: *Developing a monitoring trap for pollen beetle*

- In replicated field experiments 2008-2011, Phenylacetaldehyde performed most consistently and was chosen for further development as the lure for the field trap
2. Monitor pest density & assess risk

Monitoring methods: *Developing a monitoring trap for pollen beetle*

Spring 2013 - Commercially available from Oecos [www.oecos.co.uk](http://www.oecos.co.uk)

- Good indication of when beetles are moving but not currently adequately calibrated to allow threshold determination 😞

- Best to site traps facing upwind but located downwind of prevailing wind (usually NE side of field) most effective

[Image of monitoring trap in a field]

Skelern, Welham, Watts & Cook (2017) Agriculture, Ecosystems & Environment 24: pp.150-159...
2. Monitor pest density & assess risk

• Does it *really* matter where in the field the transect sampling is done?

• Need to understand:
  - spatio-temporal abundance and distribution of pollen beetle
  - how this relates to plant density and crop growth stage

• 3 fields at Rothamsted divided into grid 16 x 16m
• 3 plants in each zone sampled 3/week 9 March – 27 April
2. Monitor pest density & assess risk
## 2. Monitor pest density & assess risk

<table>
<thead>
<tr>
<th>Field</th>
<th>Plants/m²</th>
<th>Distance from crop edge</th>
<th>Transect mean</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Position</td>
<td>1-10 m</td>
<td>10-20 m</td>
</tr>
<tr>
<td>Great Harpenden¹</td>
<td>NE</td>
<td>27 (25)</td>
<td>33 (18)</td>
</tr>
<tr>
<td></td>
<td>SW</td>
<td>27 (25)</td>
<td>25 (25)</td>
</tr>
<tr>
<td></td>
<td>NW</td>
<td>22 (25)</td>
<td>32 (18)</td>
</tr>
<tr>
<td>Whole field average</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Long Hoos²</td>
<td>NE</td>
<td>29 (25)</td>
<td>6 (25)</td>
</tr>
<tr>
<td></td>
<td>SE</td>
<td>61 (11)</td>
<td>11 (25)</td>
</tr>
<tr>
<td></td>
<td>SW</td>
<td>30 (18)</td>
<td>11 (25)</td>
</tr>
<tr>
<td></td>
<td>NW</td>
<td>58 (11)</td>
<td>10 (25)</td>
</tr>
<tr>
<td>Whole field average</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Little Knott ¹³</td>
<td>NE</td>
<td>35 (18)</td>
<td>44 (18)</td>
</tr>
<tr>
<td></td>
<td>SE</td>
<td>40 (18)</td>
<td>39 (18)</td>
</tr>
<tr>
<td></td>
<td>SW</td>
<td>60 (11)</td>
<td>54 (11)</td>
</tr>
<tr>
<td></td>
<td>NW</td>
<td>32 (18)</td>
<td>31 (18)</td>
</tr>
<tr>
<td>Whole field average</td>
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<td></td>
</tr>
</tbody>
</table>

- Plant density varies within field so threshold varies according to position of sample

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2. Monitor pest density & assess risk

- Pollen beetle spatio-temporal abundance highly variable
2. **Monitor pest density & assess risk**

Real-time monitoring of insect pests is needed!

- Machine learning enables detection and recognition of insect species
- Camera traps being developed
- LIDAR (Light Detection and Ranging (LIDAR) ‘laser’ sensor technology being tested to detect OSR pests & beneficials
2. Monitor pest density & assess risk

expert.com on-line risk assessment tool for: pollen beetle
Predicts: start of migration, peaks in migration, end of migration
2. Monitor pest density & assess risk

- Trapping data from 178 crops across UK over 4 years
- proPlant can accurately forecast start, peaks (risk periods) and end of immigration;
- Focussing monitoring effort to when it is most needed, reducing it by half cf. rule based advice

2. Monitor pest density & assess risk

ProPlant tool now available free to UK growers via Bayer Pollen Beetle Predictor

www.bayercropscience.co.uk/

Immigration start

Immigration risk

% completion
3. Prevention

Cultural methods

• Crop Management
  Reviewed by Skellern & Cook - coming soon in special issue on Pollen beetle in Arthropod-Plant Interactions
3. Prevention

Cultural methods

• Use of pest-resistant cultivars

In research pipeline - Reviewed by Hervé & Cortesero (2016) APIS 6: 463-475
3. Prevention: Use of pest resistant cultivars

Manipulation of petal colour – red oilseed rape

- Pollen beetles are attracted to ‘yellow’; Cultivars with petal colour other than yellow are less attractive!  
  
3. Prevention: Use of pest resistant cultivars

Manipulation of petal colour – red oilseed rape

- Attracted to ‘yellow’; Cultivars with petal colour other than yellow are less attractive!  
3. Prevention: Use of pest resistant cultivars

Reduction of attractive plant volatiles

- Attracted to host plant volatiles including isothiocyanates (breakdown products of glucosinolates)

Alkenyl GS  →  3-butenyl isothiocyanate
Indolyl GS  do not catabolise to form stable ITC

3. Prevention: Habitat diversification

Cultural methods

- Habitat diversification
  Reviewed by Skellern & Cook coming soon in special issue on Pollen beetle in Arthropod-Plant Interactions

Trap cropping
3. Prevention: Habitat diversification - trap cropping

Turnip rape (*Brassica rapa*) trap crop

More attractive than oilseed rape for pollen beetles

- early flowering nature
- more attractive scent (e.g. phenylacetaldehyde)

Cook et al., 2006; *Ent. Exp. Appl.* 119:221-9
Cook et al., 2007 *Arthropod-Plant Interactions* 1:57-67
3. Prevention: Habitat diversification (intercropping, cover crops, mixed cropping, **trap cropping**)

Replicated field plots

Pollen beetles can be reduced to below spray thresholds in plots with early flowering trap crops
Whole field experiments successful  ... But cost:benefit analysis revealed current system NOT currently economically viable for conventional growers (UK)  

Cook et al (in prep)
3. Prevention: Use of semiochemicals

- **Non-host volatiles as repellents**  *e.g. Lavendula angustifolia*

  Essential oil

  Cook & Mauchline *in prep*

  Successful at field trial stage; limitations are cost and formulation
4. Control

- Mechanical e.g. trapping (commercialized)

http://www.csalomontraps.com/
4. Control: Bio-insecticides

Commercialized

**Spinosad** insecticide active via contact/ingestion based on chemical compounds found in the bacterial species *Saccharopolyspora spinose* (not in EU)
4. Control: Bio-insecticides

In research pipeline

- Entomopathogenic fungi
e.g. *Metarhizium anisopliae*, *Beauveria bassiana*

- Pathogenic nematodes
e.g. *Steinernema feltiae*
4. Control: Botanical insecticides

Commercialized
Pyrethrum

Research pipeline:
Neem

*Carum carvi*
*Thymus vulgaris*

Pavela (2011) Industrial Crops and Products 34:888-892

CARE!
Many are broad spectrum!
4. Control: Conservation biocontrol

- 80% biocontrol
- Overwinter as cocoons in soil; susceptible to tillage
4. Control: Conservation biocontrol

Conservation biocontrol of parasitoids of OSR pests via field margins designed to deliver biocontrol:

Inclusion of *Brassica napus* subsp. Biennis Forage rape

Good to support populations of parasitoids of pollen beetles, seed weevils and pod midge

Skellern & Cook et al., Submitted

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Yes we’re nearly there! (but not quite....)

1. Set action threshold  
2. Monitor pest density & assess risk  
3. Prevention( )  
4. Control ( )
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Cereals & Oilseeds

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