The Vital Role of IPM

Tom Bradshaw

National Farmers’ Union
Political Backdrop in the UK

- “Green Brexit”
- 25 Year Environment Plan
- Review of the National Action Plan
- EU Review of how Member States are implementing Sustainable Use Directive
- An increasingly precautionary approach from Defra, ECP, CRD
Regulation of PPP’s
Defra’s View of IPM

25 Year Environment Plan

iv. Protecting crops while reducing the environmental impact of pesticides

We must protect people and the environment from the risks that pesticides can pose. At the same time, farmers need to protect their crops. We should put Integrated Pest Management (IPM) at the heart of an in-the-round approach, using pesticides more judiciously and supplementing them with improved crop husbandry and the use of natural predators. More can be done in the way we breed our plants for traits beyond productivity, making better use of genetics and the resources held in gene banks to ensure their natural resilience to pests and diseases.

For too long, IPM has simply been viewed as good practice for farmers to do voluntarily. By making IPM central to our approach we will encourage wider investment in research and development. By reducing the use of pesticides in the round and deploying them in a more targeted way, it is possible to reduce the impact on the environment while keeping open a sufficient diversity of options to avoid the build-up of resistance and the need for higher doses.

We recently announced that the UK supports further restrictions on the use of neonicotinoid pesticides because of the growing weight of scientific evidence they are harmful to bees and other pollinators. Unless the scientific evidence changes, the Government will maintain these increased restrictions after we leave the EU.
INTEGRATED PEST MANAGEMENT

FARMERS USE A RANGE OF TECHNIQUES TO REDUCE THE IMPACT OF PESTS AND DISEASES ON THEIR CROPS AND MINIMISE THE USE OF PESTICIDES

- **Cultivation Technique**: preparing the land to prevent pest build up and to control weeds
- **Crop Rotation**: planting different crops in a field each year to maintain soil health and disrupt pests
- **Cover Crops**: to protect the soil, reduce erosion, improve soil and water quality, improving fertility between harvested crops
- **Resistant Crop Varieties**: Varieties of crops that are more naturally resistant to diseases and pests
INTEGRATED PEST MANAGEMENT

Farmers use a range of techniques to reduce the impact of pests and diseases on their crops and minimise the use of pesticides.

**Spring/Autumn Planting**
Planting crops at different times of the year when pests are less prevalent.

**Seeding Density**
Managing the number of seeds planted to reduce the chance of weeds and pests taking hold.

**Habitat for Beneficial Insects**
Providing areas where insects that feed on pests can thrive.
IPM Case Studies
IPM case studies
How to Make IPM Successful

1. Research and Development of IPM solutions
2. Knowledge exchange
3. Pioneers to prove concept

Political Will

Investment
Session One – Crop protection in cereals & oilseeds
Where next for slug control in the UK

Gordon Port
Newcastle University
Slugs – Recent History

- Slugs are a persistent, but unpredictable problem
- Metaldehyde in water at times exceeds 0.1ppb
- Metaldehyde Stewardship Group
- Catchment Management: e.g. Anglian Waters, Severn Trent Water
- Research on new pellet formulations
- Metaldehyde withdrawal
  - 31 December 2020: Deadline for the sale and distribution of metaldehyde slug pellets
  - 31 December 2021: Deadline for the disposal, storage and use up of existing stocks

https://www.getpelletwise.co.uk/2016/09/09/farm-level-measures-under-the-spotlight/ accessed 16/3/18
New Pellets

• Slug pellets are mostly food
• Can we bind metaldehyde more effectively?
New Pellets

• Does concentration of metaldehyde affect pellet finding?

Time taken (mean + SE) for 32 slugs to find pellets of either 1, 3 or 5% metaldehyde during 14 hours exposure.
Does concentration of metaldehyde affect poisoning?

Percentage of slugs either dead or paralysed after 14 hours’ exposure to 0, 1, 3 or 5% metaldehyde pellets
New Pellets

• How much feeding?
New Pellets

• How much feeding?
New Pellets

- How much feeding?

**Cereal pellet**

**Metaldehyde pellet**
New Pellets

• How much feeding?
Finding Pellets

Probability of encountering a bait in six hours

Probability of mortality after 14 days
Probable Impact of Pellets

- Pellets applied: 100%
- Slugs killed: 60%
- Recolonisation 2 weeks: 30%
- Recolonisation 4 weeks: 10%

Legend: Blue = Aspiration, Green = Live slugs
Where next - IPM

- Avoidance – Risk factors
- Previous crop
- Cultivation
- Encourage predators such as ground beetles
IPM – monitoring/forecasting

• Long term forecasting not reliable
• Monitor, especially just before risk period
• Good understanding of conditions when slugs are active, causing damage: Trap or Treat
  • Soil surface moist
  • Temperature above 5°C
## IPM - thresholds

<table>
<thead>
<tr>
<th>Crop</th>
<th>Threshold (average number of slugs/trap)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winter cereal</td>
<td>4</td>
</tr>
<tr>
<td>Oilseed rape (standing cereals)</td>
<td>4</td>
</tr>
<tr>
<td>Oilseed rape (cereal stubble)</td>
<td>1</td>
</tr>
<tr>
<td>Potatoes</td>
<td>1</td>
</tr>
<tr>
<td>Field vegetables</td>
<td>1</td>
</tr>
</tbody>
</table>
IPM – management options

• Sustainable non-chemical methods
• Cultivation
• Encourage predators such as ground beetles
• Specific applications
• Bait pellets
• Be aware of their limitations
IPM – management options

• Keeping interventions at levels that are necessary
• Reduced doses
• Treating hotspots
• Resistance?
• Very unlikely

Distribution of *Deroceras reticulatum* in June 1997 in winter wheat (from LARS)
Slug Pests - Conclusions

- Slugs are difficult to manage
- IPM involves
  - crop rotation
  - cultivations
- if necessary (after monitoring) use of molluscicides
- Molluscicides should be used
  - when weather is suitable
  - shortly before crop is at risk
Thanks

• Funders
  Defra / AHDB / Arable/Horticulture LINK / Perry Foundation / Agrochemical Industry and other collaborators
  • PhD students & Research Associates

• Especially
  • UKWIR
  • Lucideon
  • Amy Campbell
  • Samantha de Silva
‘Inspiring our farmers, growers and industry to succeed in a rapidly changing world’
The consequences of a total ban on neonicotinoid seed treatments for BYDV control in cereals: a return to IPM principles?

Alan M. Dewar
Dewar Crop Protection Ltd.
www.dewarcropprotection.co.uk
Sustainable Use Directive principles on Integrated Pest Management

1. Achieving prevention and suppression of harmful organisms
2. Monitoring of harmful organisms
3. Decisions made based on monitoring and thresholds
4. Non-chemical methods
5. Pesticide Selection
6. Reduced Use
7. Anti-resistance strategies
8. Evaluation

What are the harmful organisms?

- BYDV infection is caused by several strains (some would say ‘species’) of a luteovirus that are all transmitted by...
  - Aphids, and ONLY aphids
  - Most common strains in UK include PAV, MAV and RPV
  - The latter strain has been classed as a polerovirus within the Luteoviridae
Pest of cereals in the UK

<table>
<thead>
<tr>
<th>pest</th>
<th>species</th>
<th>Time of year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grain aphids</td>
<td><em>Sitobion avenae</em></td>
<td>Autumn, BYDV, summer</td>
</tr>
<tr>
<td>Rose-grain aphids</td>
<td><em>Metopolophium dirhodum</em></td>
<td>summer</td>
</tr>
<tr>
<td>Bird-cherry aphids</td>
<td><em>Rhopalosiphum padi</em></td>
<td>Autumn, BYDV</td>
</tr>
<tr>
<td>Wheat bulb fly</td>
<td><em>Delia coarctata</em></td>
<td>winter</td>
</tr>
<tr>
<td>Gout fly</td>
<td><em>Chlorops pumilionis</em></td>
<td>Autumn, spring</td>
</tr>
<tr>
<td>Wheat orange blossom midge</td>
<td><em>Sitodiplosis mosellana</em></td>
<td>spring, summer</td>
</tr>
<tr>
<td>Saddle gall midge</td>
<td><em>Haplodiplosis marginata</em></td>
<td>summer</td>
</tr>
</tbody>
</table>

Likely to be affected by neonicotinoid ban

From Dewar *et al.*, AHDB Research Review No. 86 (2016)
Target pests for insecticides in wheat in the UK

2016

- 93
  - aphids: 5
  - OWBM: 2
  - Others: 2

2018

- 95
  - aphids: 3
  - OWBM: 2
  - Others: 0

Source: Pesticide Usage Surveys in Arable Crops: Garthwaite et al., 2018 and 2019
Target pests for insecticides in winter barley in the UK

2016
- Aphids: 97
- Others: 3

2018
- Aphids: 99
- Others: 1

Source: Pesticide Usage Surveys in Arable Crops: Garthwaite et al., 2018 and 2019
The bird cherry-oat aphid, *Rhopalosiphum padi*

- Important pest on wheat, barley and oats
- Transmits BYDV - PAV and RPV strains
- Formerly good control with Deter seed treatment
- Continuing good control with pyrethroids

But....
A pyrethroid resistant/tolerant clone of *R padi* has recently been recorded in Ireland, so watch this space
It is the asexual forms which are the main vectors of BYDV in cereals

Life cycle of *R. padi*
The grain aphid, *Sitobion avenae*

- Important pest on wheat, barley and oats
- Can reduce grain yield
- Transmits BYDV - MAV and PAV strains
- Previous good control with Deter and pyrethroids
- Control failures reported in summer 2011 and springs of 2012 and 2016
Epidemics are occurring more often in the autumn due to global warming, causing BYDV infection in following spring.

Crops near Elveden and Lakenheath in 2012

These epidemics have often been associated with the presence of grain aphids, NOT bird cherry aphids.
Use of neonicotinoid seed treatments in winter and spring wheat in GB: 1999-2018

Source:
Use of neonicotinoid seed treatments in winter barley in GB: 2000-2018

Source:
Use of insecticides in cereals in the UK in 2018: the top 5 are all pyrethroids

Source: Pesticide Usage Survey, Report 284: Garthwaite et al., 2019
Target pests for insecticides in winter wheat in the UK 2017-2018

Source: Pesticide Usage Survey in Arable Crops, 284: Garthwaite et al., 2019
Target pests for insecticides in winter barley in the UK 2017-2018

Source: Pesticide Usage Survey in Arable Crops, 284: Garthwaite et al., 2019
Target pests for insecticides in spring barley in the UK 2017-2018

87% of insecticides in spring barley are applied to control aphids

Source: Pesticide Usage Surveys in Arable Crops, 284: Garthwaite et al., 2019
SUD 2. Monitoring of harmful organisms

• Aphids must migrate into cereal fields each autumn
• So their migrations can be monitored
  – By suction traps
  – By sticky traps
  – By water traps
  – By direct observation in crops
Rothamsted Insect Survey suction trap sites

http://www.rothamsted.ac.uk/insect-survey/STTrapSites.php
Recent migrations of aphids in suction trap: bird cherry oat aphid
Recent migrations of aphids in suction trap: grain aphid
Other traps

These do require the skills of an entomologist

Yellow water trap

Insect soup

Sticky trap
SUD 3. Decisions made based on monitoring and thresholds (1)

• Thresholds for aphid control with regard to suppressing BYDV are variable, and lack data to underpin their accuracy e.g. 10% of plants infested

• So, in practice, growers and agronomists assume that...
  – the only good aphid is a dead one!
  – therefore, in the absence of seed treatments, sprays are applied when the first aphid is seen.

Can this approach be changed?
SUD 3. Decisions made based on monitoring and thresholds (2)

• Needs better information on the threat of virus infection including:
  – Infectivity indices for each region in the country using trap data
  – this in turn requires information on
    • The proportion of those aphids carrying viruses
    • The proportion of those aphids that are resistant to pyrethroids to guide choice of insecticides
Resistance status of *Sitobion avenae* samples collected in 2012

Survey funded by Syngenta Crop Protection
Resistant and susceptible *Sitobion avenae* in RIS suction trap samples in 2012

Source: Steve Foster and Martin Williamson at Rothamsted Research
Frequency of resistant *Sitobion avenae* in Rothamsted Insect Survey suction traps: 2009 - 2015

Rothamsted not tested in 2009 and 2010; lack of funding has prevented more recent surveys.
## BYDV incidence / suction trapped R. padi October 2018

Pilot study: <100 aphids tested / trap

<table>
<thead>
<tr>
<th>Trap</th>
<th>R padi</th>
<th>% BYDV</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>625</td>
<td>18</td>
</tr>
<tr>
<td>Y</td>
<td>15808</td>
<td>12</td>
</tr>
<tr>
<td>P</td>
<td>15995</td>
<td>15</td>
</tr>
<tr>
<td>K</td>
<td>11887</td>
<td>3</td>
</tr>
<tr>
<td>BB</td>
<td>8696</td>
<td>13</td>
</tr>
<tr>
<td>We</td>
<td>6929</td>
<td>6</td>
</tr>
<tr>
<td>H</td>
<td>6445</td>
<td>3</td>
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<tr>
<td>RT</td>
<td>3734</td>
<td>0</td>
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<tr>
<td>Wr</td>
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<td>21</td>
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<td>SP</td>
<td>2752</td>
<td>4</td>
</tr>
<tr>
<td>W</td>
<td>6406</td>
<td>8</td>
</tr>
<tr>
<td>SX</td>
<td>3971</td>
<td>8</td>
</tr>
</tbody>
</table>

Insect Survey network: Newcastle, York, Kirton, Wellesbourne, Hereford, Rothamsted, Brooms Barn, Writtle, Silwood Park, Wye & Starcross

Source: Martin Williamson at Rothamsted Research
Percentage *R. padi* carrying BYDV (PAV and MAV) and CYDV-RPV across five English suction traps in autumn 2019

**Diagram:**

- **Virus strain:** PAV/MAV, RPV
- **Trap location:** Starcross, Writtle, Brooms Barn, Kirton, Newcastle
- **Number tested above columns:**
  - Starcross: 422
  - Writtle: 314
  - Brooms Barn: 274
  - Kirton: 220
  - Newcastle: 310

**Source:** Martin Williamson at Rothamsted Research
SUD 4. Non-chemical methods

- Delaying drilling until immigration threat is reduced or even eliminated e.g. November
  - Encouraged by blackgrass situation
  - Can result in reduced yields
  - Can be caught by inclement weather e.g. in 2019

- Use of BYDV resistant/tolerant varieties
  - No pesticides required at all
  - Can yields match top varieties?
BYDV resistant/tolerant varieties

• Some varieties now coming through development
  – Amistar (KWS) and Rafaela (LG Seeds) in winter barley
  – Wolverine (RAGT) in winter wheat
In absence of neonicotinoid seed treatments, there is a huge reliance on one class of chemical
- Top 5 insecticides used are all **pyrethroids**

Nothing else is registered for use in autumn at the moment
- This must change
Both treatments gave significant control of the vector *R. padi*
Effect of pyrethroids on BYDV infection spread by bird-cherry aphids
SUD 6 Reduced Use

• In absence of effective seed treatments use of pyrethroids is likely to increase significantly
  – perhaps double the previous use?
  – although perhaps not this year given the inclement weather

• This is likely to lead to selection for resistance
SUD 7. Anti-resistance strategies

1. Urgent need for alternative chemistry given resistance situation with *Sitobion avenae* (up to 50% in some regions)

2. And higher risk of selection for resistance in *Rhopalosiphum padi*
Efficacy of insecticides in winter barley against aphids in 2016

Elveden: 25 October, 8 DAS

aphids inoculated on 14 October; sprays applied on 17 October
Efficacy of insecticides in winter barley against aphids in 2016

Elveden: 25 October, 8 DAS

aphids inoculated on 14 October; sprays applied on 17 October:
For example, BYDV epidemic in 2016: Barrow, Suffolk

Associated with grain aphids, *Sitobion avenae*, that were resistant to pyrethroids
Efficacy of insecticides in winter rye against cereal aphids in 2017

Butley: 16 October, 7 DAS

sprays applied on 9 October: R pad = Rhopalosiphum padi; Sav = Sitobion avenae; W+ = winged; W- = wingless
SUD 8 Evaluation

• Surveys of use of pesticides (already done through PUS)
• Surveys of incidence of BYDV across the country
  – Not done regularly at present
  – Could identify regions with higher risk and allow focus of effort there
  – Ideally should be done in untreated crops or part crops
A glimpse of the future

• Infochemicals: cis-jasmone; (E)-beta-farnesene
• RNAi – virus-derived resistance
• Field testing kits for individual aphids
• All varieties carrying resistant tolerance genes e.g. sugar beet situation with Rhizomania
• Biopesticides: neem, oils of cumin, hyssop, costmary, lavender, thyme
• Conservation control: to enhance impact of natural enemies
The ultimate in pest control

*The last aphid* by Charley Harper: 1922-2007
Good Luck
Session Two – Crop nutrition in cereals & oilseeds
Fostering Populations Of Arbuscular Mycorrhizal Fungi Through Cover Crop Choices and Soil Management

George Crane
The Problem with Food Production

- Since the 1960s
  - Incredible yield increase! But..
  - 7.5 times more nitrogen fertiliser
  - 3.3 times more phosphorus fertiliser
  - Degradation of soils

- Finite, energy intensive, and contribute to global climate change and pollution

(Brassley 2000; Broadberry et al. 2015; FAO 2018; Roser & Ritchie 2018)
Arbuscular Mycorrhizal (AM) Fungi

(Remy et al. 1994)
AM Fungi 450 Million Years Later

- Interact with 80% of extant land plants
- Essential for ecosystem functioning

- Studies show that colonisation by AMF resulted in:
  - 35% increase in biomass
  - 23% increase in yield

..But intensive agriculture detrimental to AM fungi

Image: Mieke Jürgens

(Van Geel et al. 2016, Lekberg and Koide 2005)
Signaling at the Root of AM Symbiosis (Choi et al. 2018)
1. The use of cover crops promote the establishment, and maintenance of a diverse range of AMF species, which facilitates increased interaction with following cash crops.

2. Increasing diversity and abundance of arbuscular mycorrhizal fungi improves soil health, crop growth, and yield of following cash crops.
Thanks

- Dr Lydia Smith and the Innovation Farm team
- Professor Uta Paszkowski and the Cereal Symbiosis lab.
- Dr Nathan Morris, Dr Liz Stockdale, David Clarke, and the trials team at NIAB Morley
- Innovative Farmers: Jim and Patrick Allpress, Andrew Blenkiron, James Beamish, Phil Rayns, Robert England, and David Wright