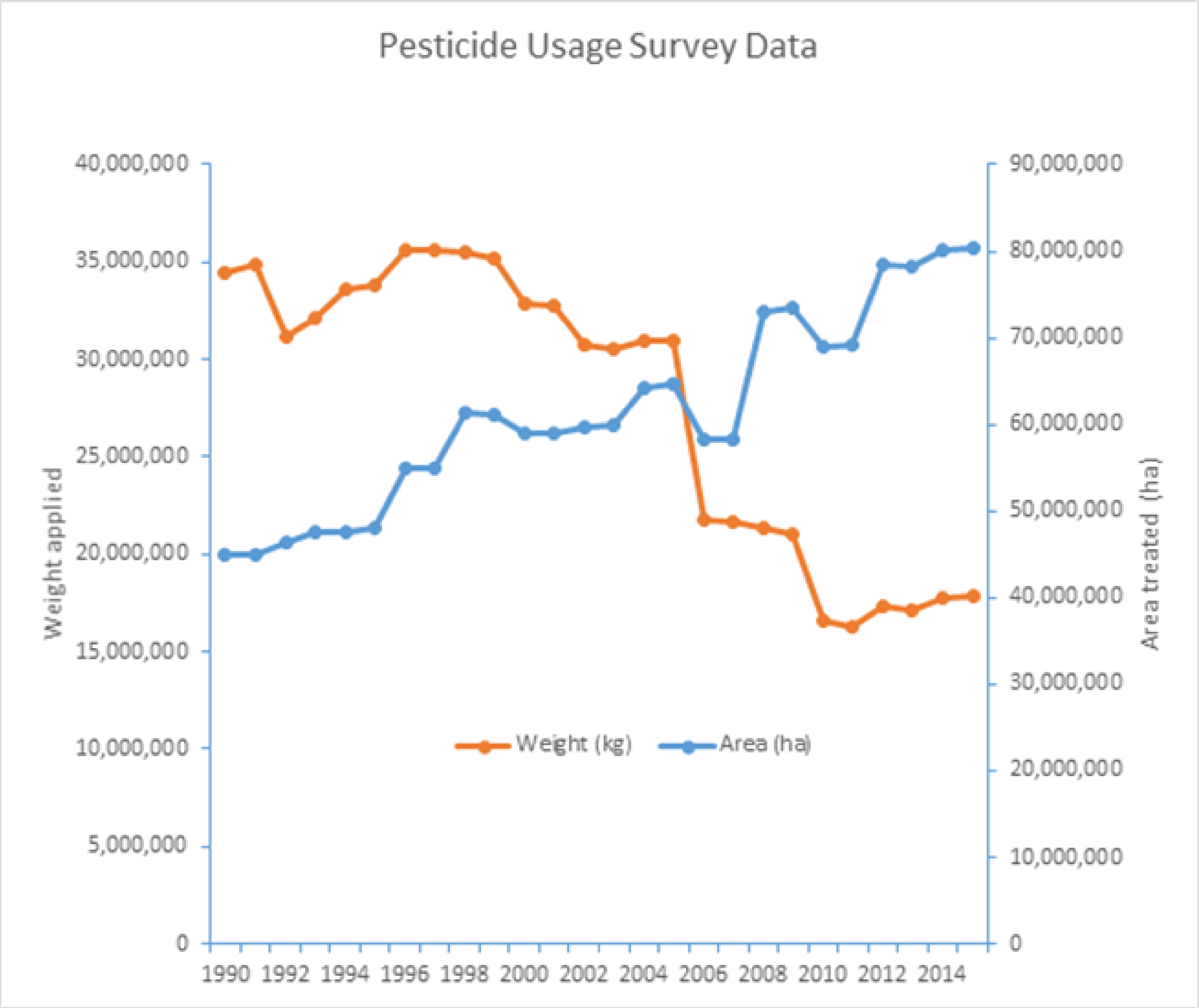
AHDB Agronomists’ Conference 2019

Tuesday 3 – Wednesday 4 December 2019

The Vital Role of IPM

Tom Bradshaw

National Farmers' Union


Pesticide Usage Survey Data
40,000,000
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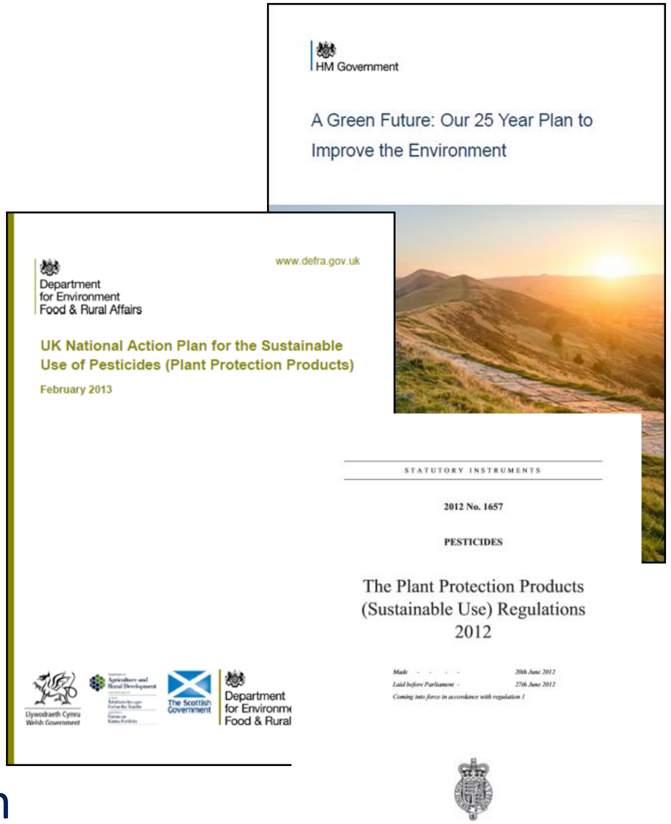
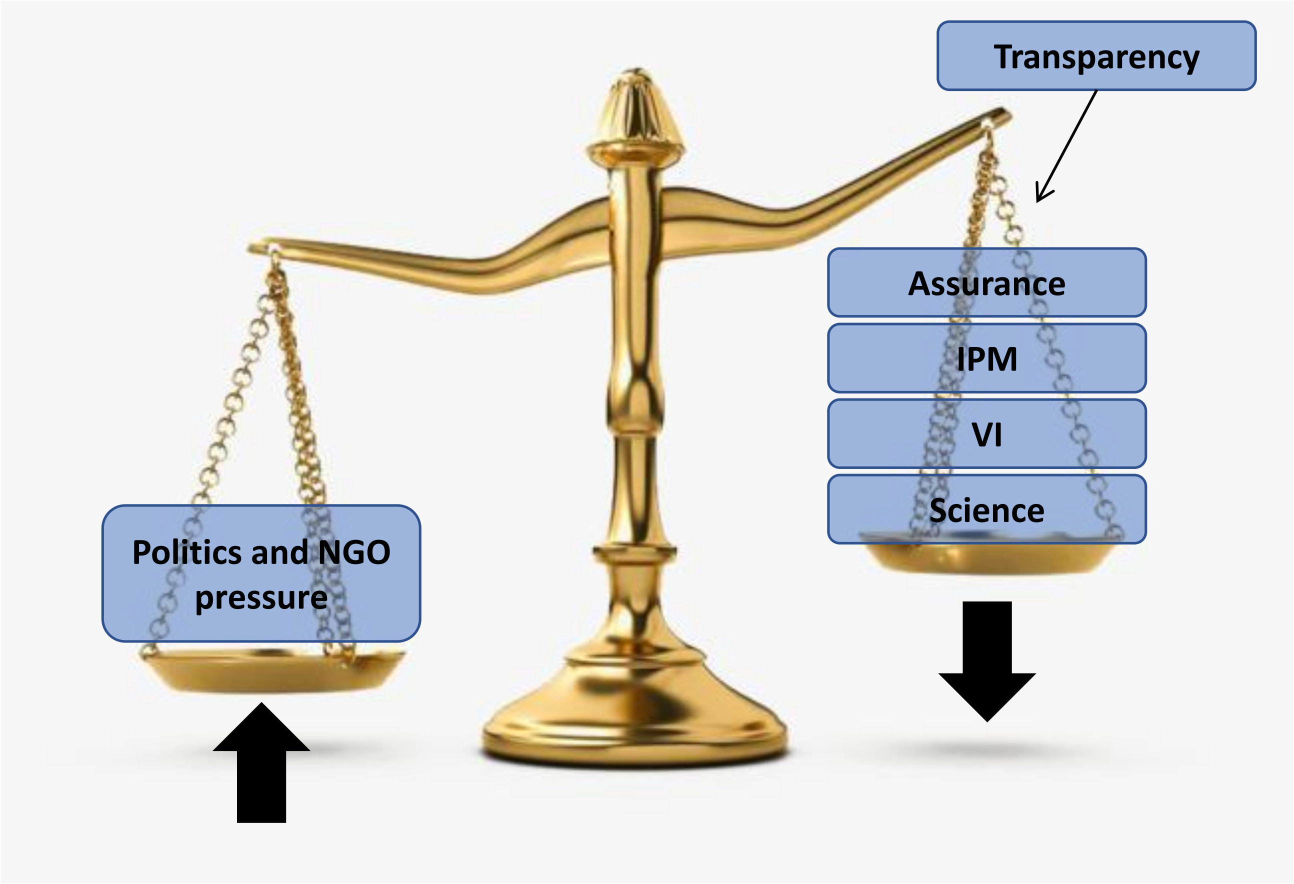
Area treated (ha)
1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014
Weight (kg)
Area (ha)

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

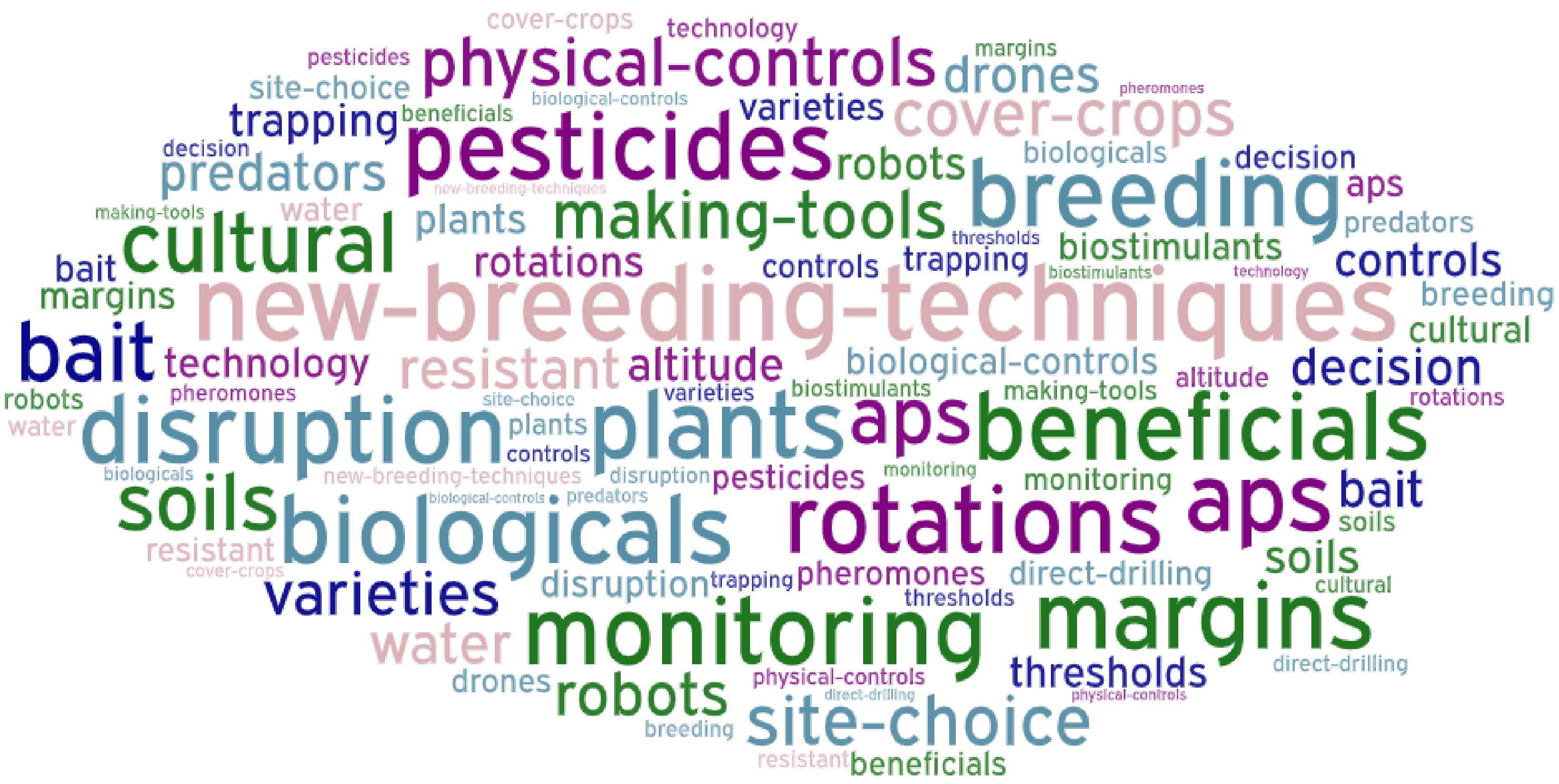
SEEDING DENSITY

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



cover-crops
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robots
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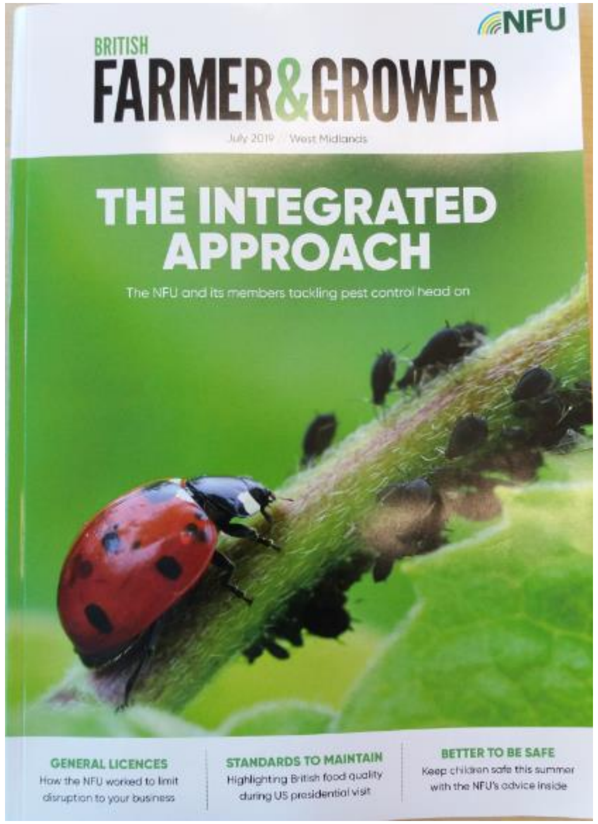
IPM Case Studies



PLANT PROTECTION

IPM

Very IPM

With many NFU members demonstrating the very best practice in IPM (Integrated Pest Management), the NFU is collating case studies to showcase growers' work to the wider farming world and policy makers

IPM is the phrase on every grower's lips. It is becoming increasingly important, not only to legally satisfy the requirements of the Sustainable Use Directive and the government's 25 year environment plan, but also to help combat the loss of so many useful pesticides through regulation and the development of resistance.

"Glyphosate has been re-approved until 2021, but the threats to its availability remain due to political pressure and the real threat of resistance," explains NFU Senior Plant Health Adviser Emma Hamer. "Grass weeds have become resistant to many other herbicides, and while we do not have any confirmed cases of glyphosate resistance in the UK, there have been cases in many other countries and there is still a real possibility that resistance could develop in the UK." By taking an integrated approach to weed management, we can help protect the availability of glyphosate and other pesticides.

Many farms already have crop protection programmes in place, using cultural controls such as rotational ploughing, spring cropping, delayed autumn drilling and extended rotations to help tackle weeds and these IPM approaches can reduce the risk of

PHIL JARVIS

"We need a better knowledge exchange of research showing proof of concept. IPM is complicated and there isn't currently a tried and tested system," says chairman of the NFU environment forum and vice chairman of the national combinable crops board, Phil Jarvis. Mr Jarvis is farm manager of The Allerton Project, the 333ha research and demonstration farm based in Loddington, Leicestershire.

The farm traditionally focuses on long-term IPM projects that encourage and increase beneficial species numbers, whilst maintaining a focus of keeping a profitable farming business. Phil explained how developing his approach to IPM has helped to take some of the risk out of their business.

He said: "By using natural processes and reducing inputs, I have reduced my costs on land and machinery so if, for instance, the weather is awful that year, it is not as big an investment." Whilst he agrees there is a greater risk of a pest infestation, he says that due to the reduced input costs he would hope to have money to cover any crop failures.

Fundamentally, Mr Jarvis's farm focuses on rotation and varietal choice. He has a seven crop rotation of barley, winter and spring beans, oats, wheat, oilseed rape and grass leys, protect his soil and reduce the costs associated with nitrogen input and cultivation. Phil also uses cover and companion cropping, soil nutrient testing, buffer strips and bait plants amongst many other IPM techniques.

22 July 2019 British Farmer & Grower

PLANT PROTECTION

WHAT ARE THE NFU'S KEY POLICY ASKS ON IPM?

- Any future agricultural policy should be science-based, support the visions set out in the government's 25 year environment plan, be uncomplicated and not too prescriptive.
- Farmers, delivering a wide range of environmental benefits, need to be at the centre of the delivery of any future ELMS scheme and lessons must be learned from flawed schemes of the past.
- Any future scheme must be accessible to all farm types, cost effective, transparent in approach and expectations, responsive to changes in farm practice and relevant to different UK landscapes.
- In order to deliver environmental benefits, businesses have to be profitable so long term support for family farms is needed.
- There must ber acknowledgement that a good IPM approach is complicated and can carry a high level of risk, as well as awareness that pesticides are an important part of an IPM approach to pest, weed and disease management.
- IPM research and development is needed, including a fit-for-purpose knowledge exchange system.
- Farmers should be rewarded for taking land out of production to put in environmental features.
- Britain should not export its environmental footprint to other territories which have access to technologies denied to UK growers, so we need production standard equivalence.

To find out more about filling out an IPM plan, visit NFUonline.com/ipm where there is a step-by-step guide to help you create an IPM plan appropriate for your farm.

For more information and advice on the latest in IPM, keep an eye on the plant protection pages of NFUonline in the coming months.

JOHN PAWSEY

John Pawsey farms 650 hectares organically at Shimpling Park Farm, and another 980 hectares (also farmed organically or in organic conversion) for others.

"We look at the overall picture, starting with the design of our rotation," explains Mr Pawsey. "It is as diverse as the market will allow and takes into account crop architecture which governs the crop's ability to outcompete weeds."

He takes a systems approach to managing pests, weeds and diseases by growing the wide rotation, choosing appropriate varieties and building fertility through clover leys. Artificial Nitrogen is not an option for organic growers so fertility is built up with leguminous crops and livestock and Mr Pawsey runs 2000 New Zealand Romney ewes to help manage grass weeds and to return fertility to the grass and clover leys they graze. Rock phosphate can be used to raise P indicies and organic matter can be added through chopped straw or biodigestate from the local sugar beet factory.

After the two year grass and clover lays (known as the regenerative phase), Mr Pawsey will plant a winter cereal – wheat, oats, spelt or heritage wheat depending on the weed burden on that field. No herbicides can be used due to the organic nature of the way he farms, so weed control has to be achieved by non-chemical means. Weeds and crop volunteers are encouraged to germinate by cultivating immediately after harvest.

John uses several passes with a Gregoire Besson disc/tine cultivator or a Horsch Terrano cultivator down to a depth of about four inches. Repeated passes take out the majority of weeds before drilling with the Swedish System Cameleon drill.

He plants on 321mm row widths allowing space for the Cameleon to go through inter-row hoeing and planting under sown grass and clover at the same time. However, John's philosophy is that mechanical hoeing is a last resort. If he can establish crops with good architecture they can shade out competitive weeds.

Mr Pawsey did point out that this mechanical weeding might not work on all soils. If there is resistance in the form of stones or flints, there will be increased crop damage.

IAN WALLER

Ian Waller is a first generation farmer from Great Missenden in Buckinghamshire. He farms 450 hectares at home and manages another 300ha for neighbours. Ian is passionate about his soils and all his land at home is direct drilled. When asked about staff, Ian joked: "I employ one man and 200 million earthworms!"

He has grass margins and hedges around all his fields (36km of hedges in total) which are not all cut every year ensuring a good supply of flowers and berries for his thriving community of insects and birds and he has made a conscious decision to not use any insecticides for the last three years. This has allowed the populations of beneficial insects to build up so natural predators control the majority of crop pests. He controls black grass by minimal soil disturbance, hand rogueing and delaying drilling until November and, by that point, aphid numbers are low so Barley Yellow Dwarf Virus (BYDV) is rarely a problem.

Mr Waller is also growing catch and cover crops so that his soil has almost year round cover which minimises water loss and soil erosion. Radish, mustard, crimson clover, phacelia and buckwheat are under-sown or spun on using a pneumatic spreader. Thus, when the wheat is harvested the cover crop is already established. These crops are providing habitat for beneficial insects; improving the fertility and deep rooted plants are improving the soil structure and drainage.

24 July 2019 British Farmer & Grower

IP

How to Make IPM Successful

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

Political Will

Investment

AHDB Agronomists' Conference 2019

Session One – Crop protection in cereals & oilseeds

Newcastle University

AHDB

Agronomists' Conference 2019

Where next for slug control in the UK

Gordon Port

Newcastle University

fera UKWIR UK Water Industry Research LUCIDEON insight creating advantage Lonza

CEREALS & OILSEEDS

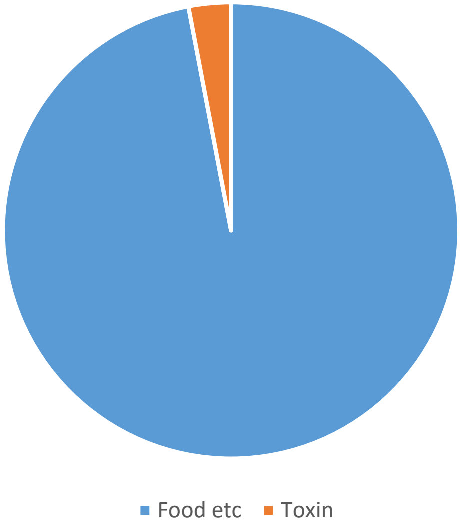
Slugs – Recent History

- 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

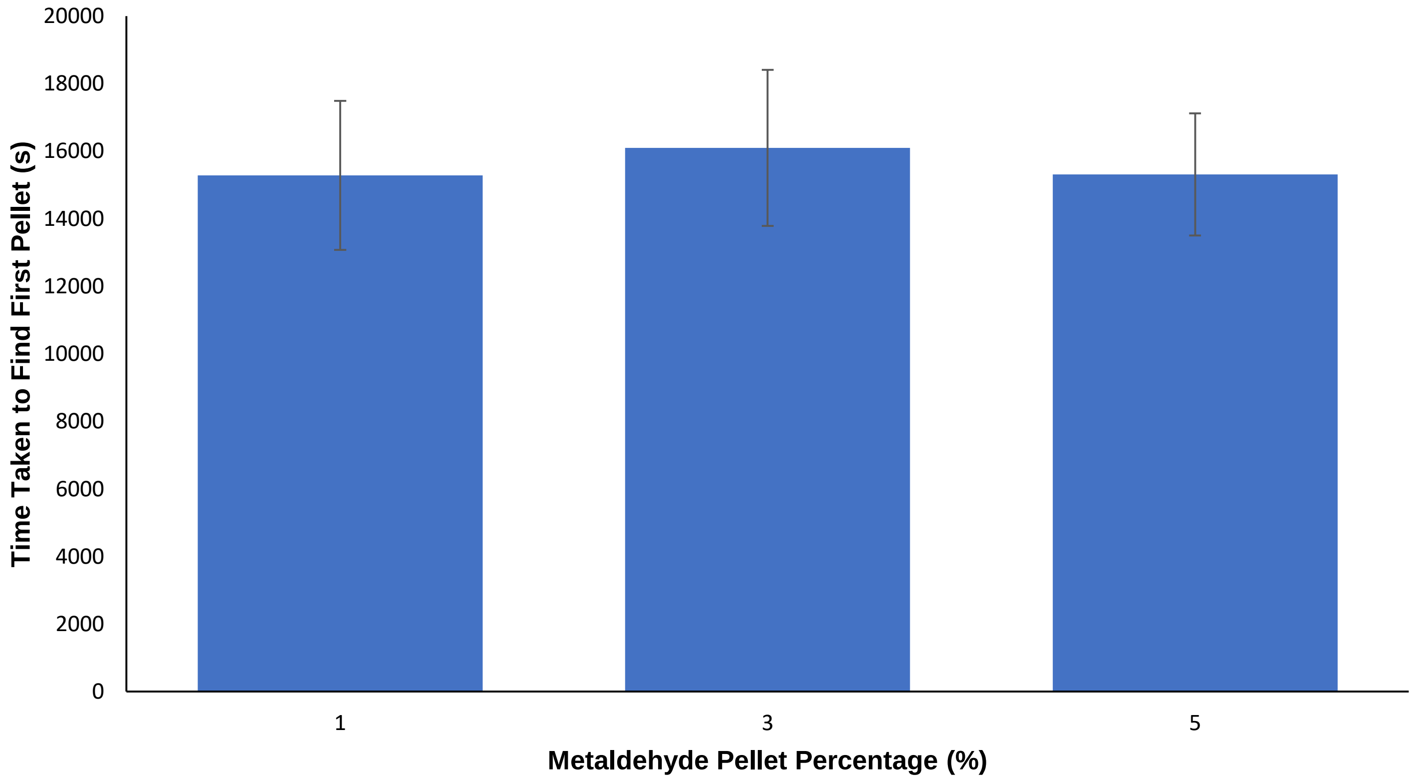
New Pellets

- Slug pellets are mostly food
- Can we bind metaldehyde more effectively?



New Pellets

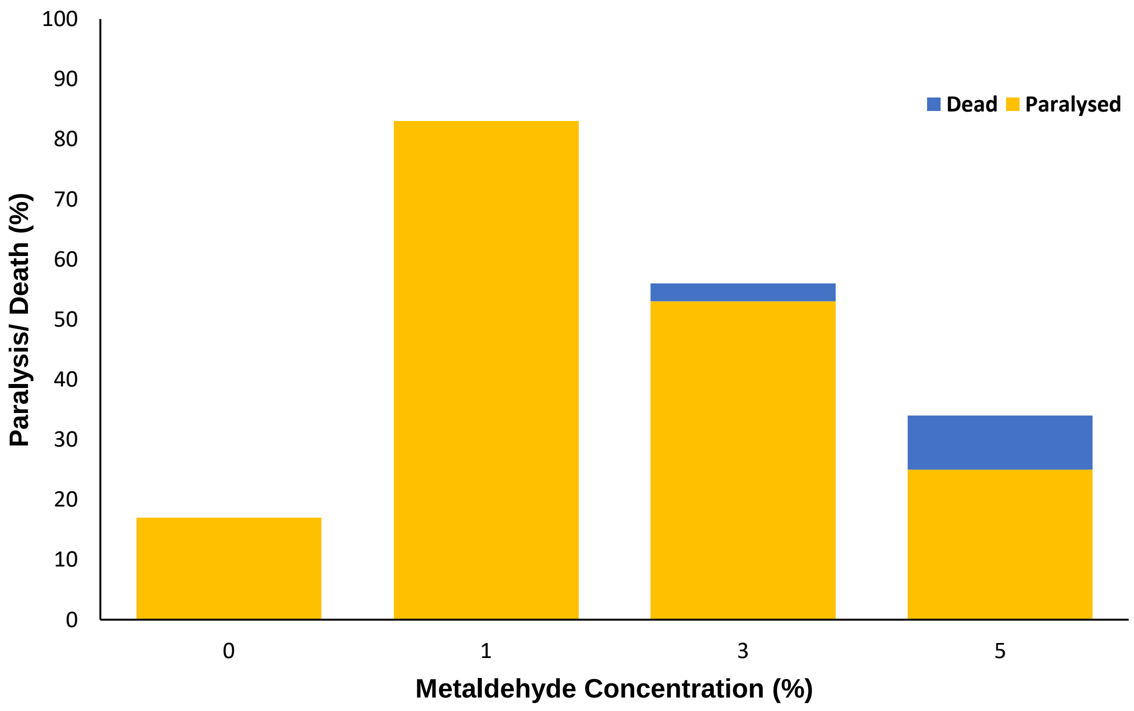
- Does concentration of metaldehyde affect pellet finding?



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

New Pellets

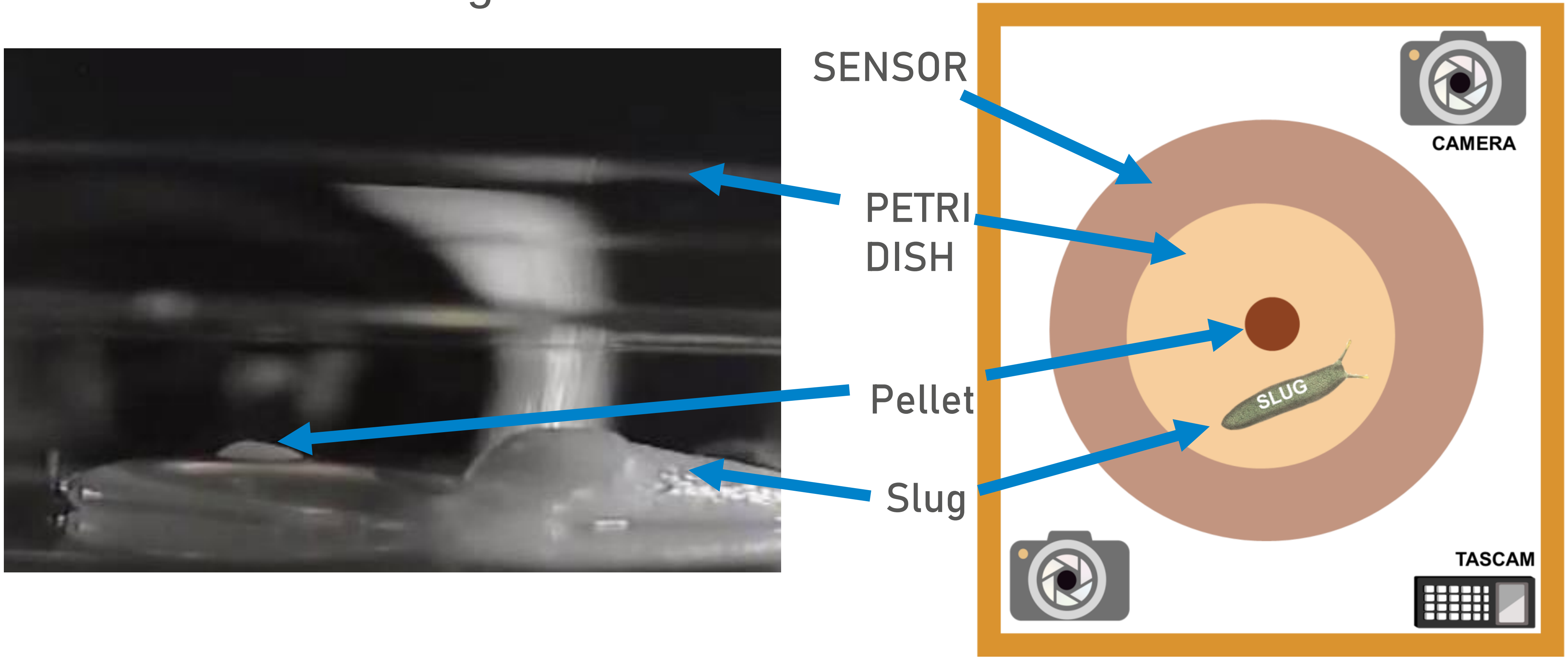
- Does concentration of metaldehyde affect poisoning?



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

New Pellets

- How much feeding?

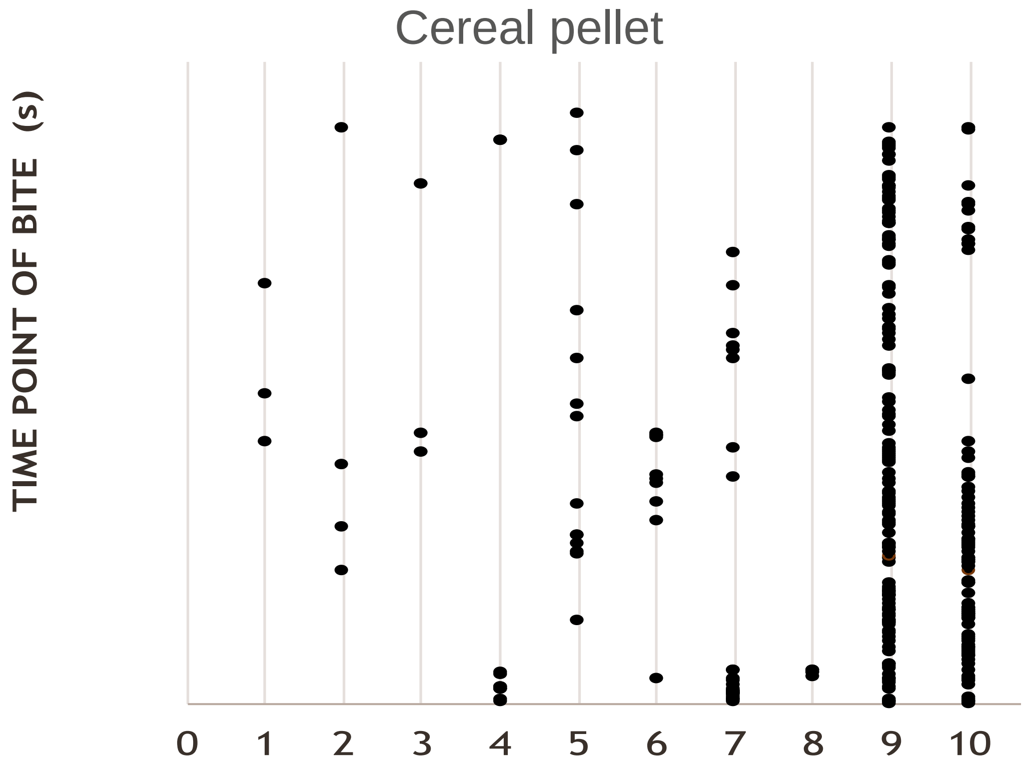


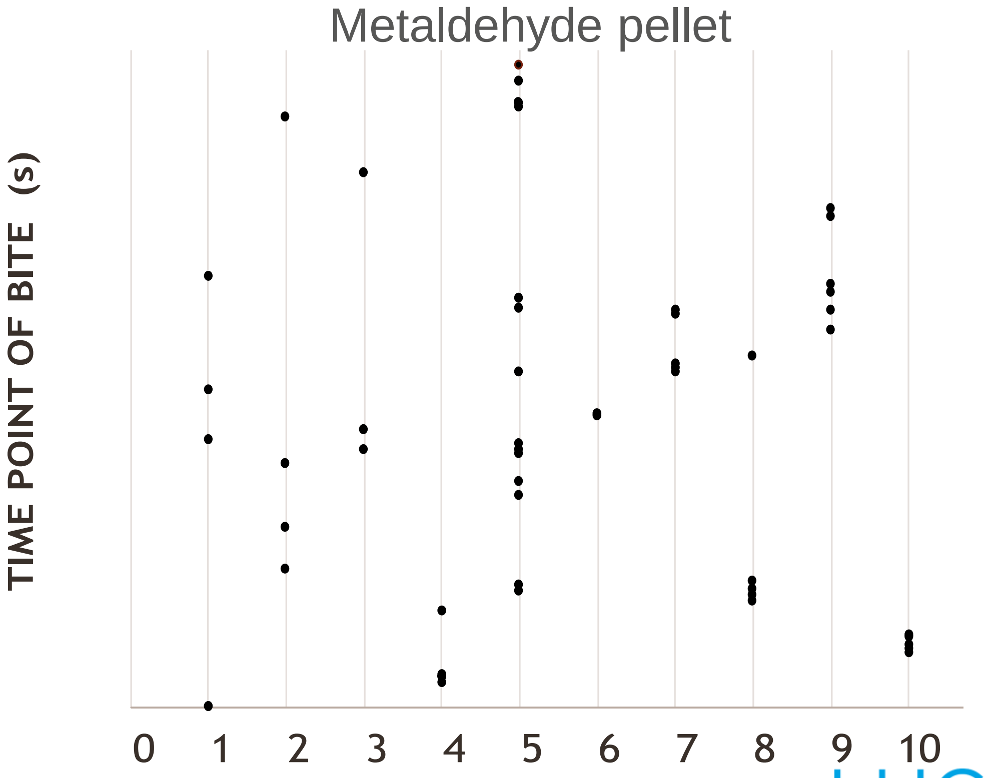
New Pellets

- How much feeding?

New Pellets

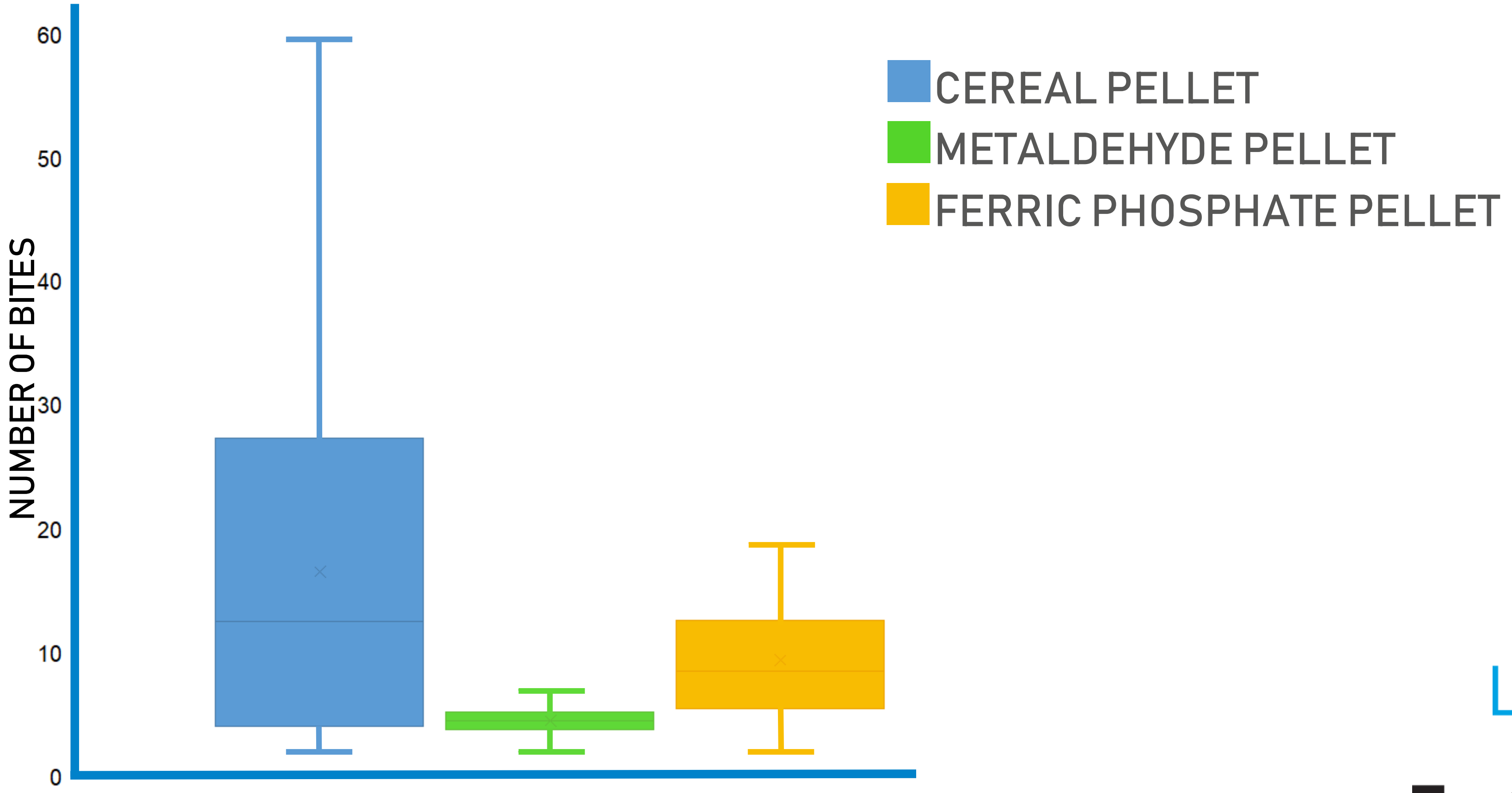
- How much feeding?



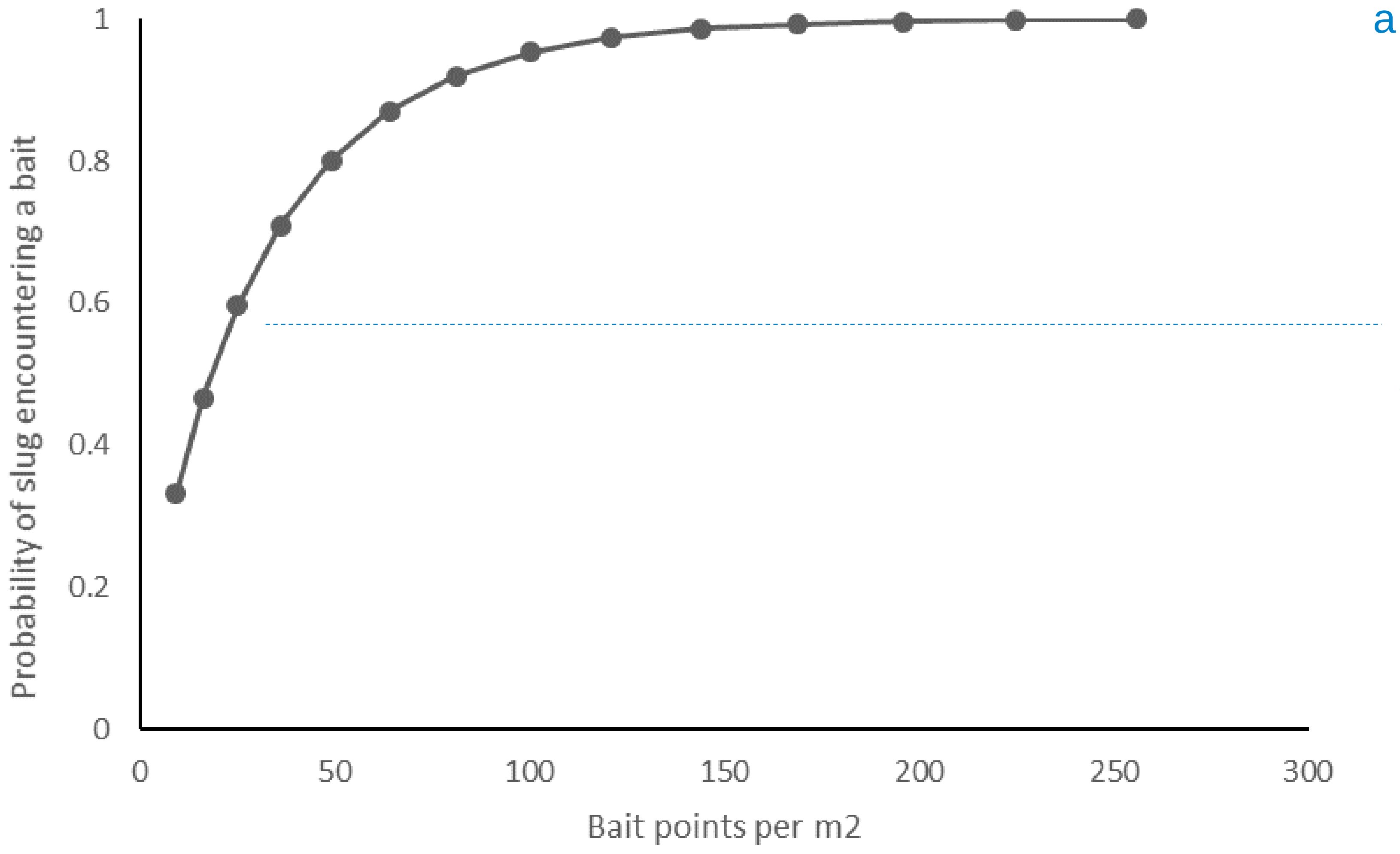


New Pellets

- How much feeding?



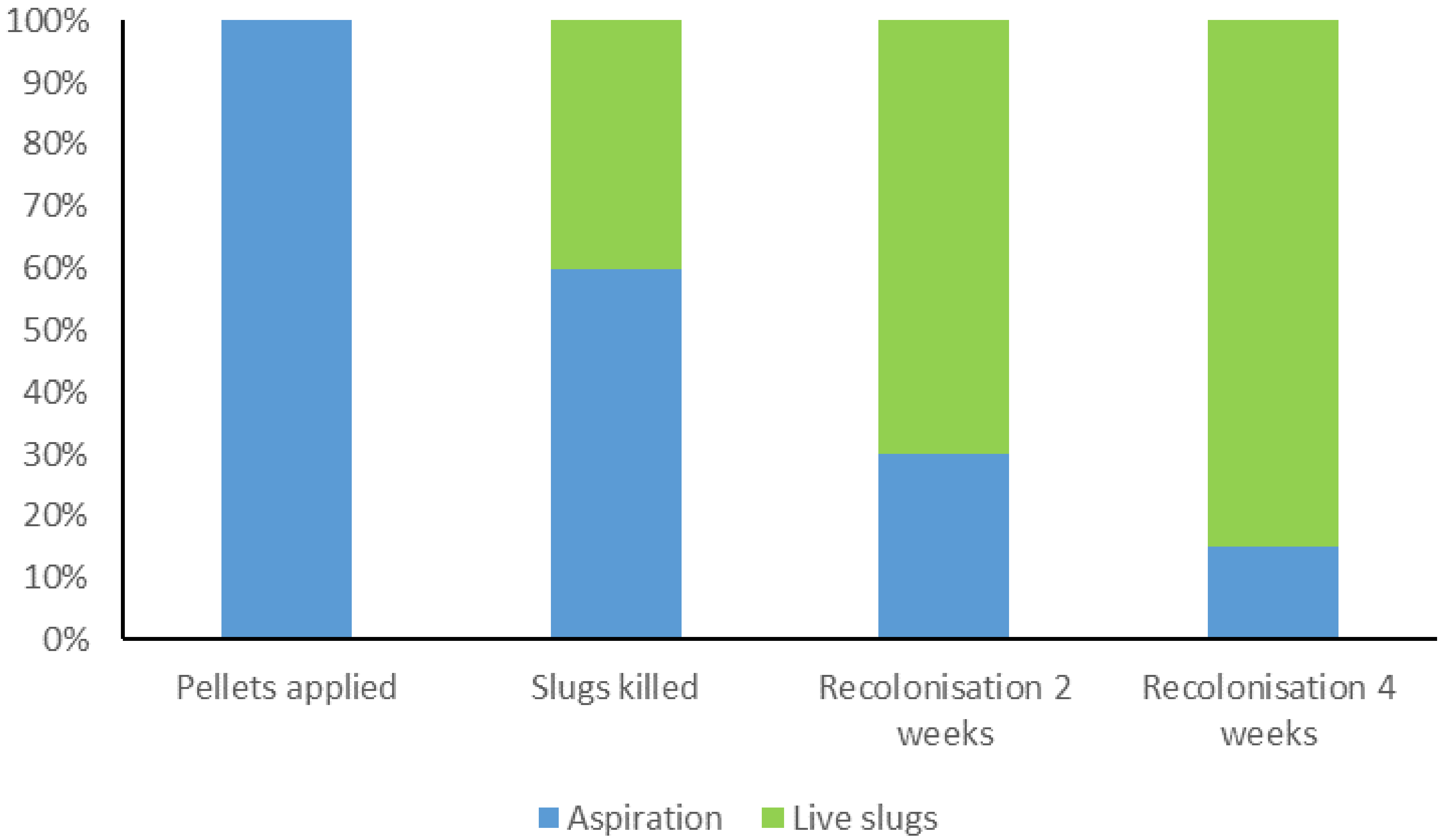
Finding Pellets



Probability of encountering a bait in six hours

Probability of mortality after 14 days

Probable Impact of Pellets

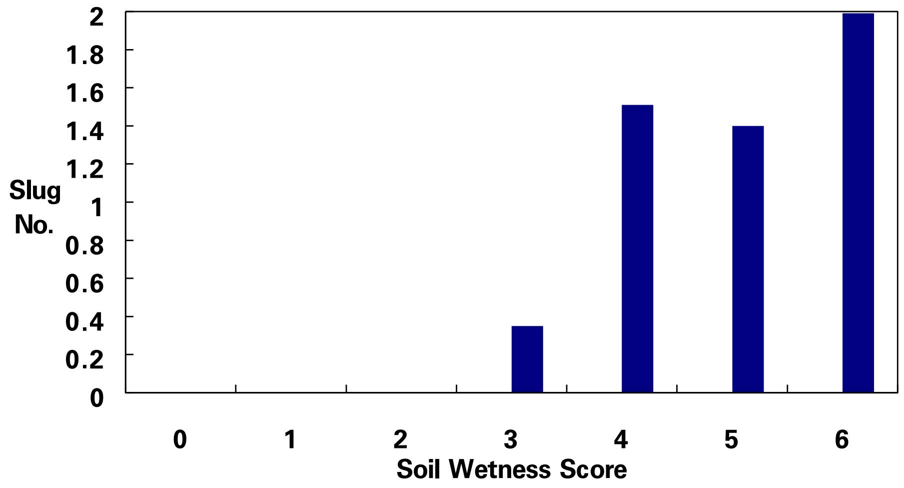


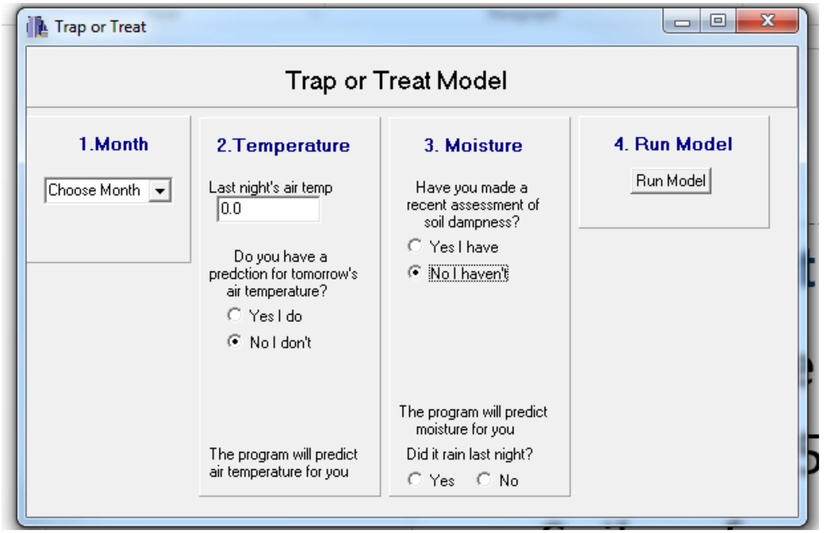
Where next - IPM

- 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^{o} C





CERTIS SLUGWATCH

IPM - thresholds

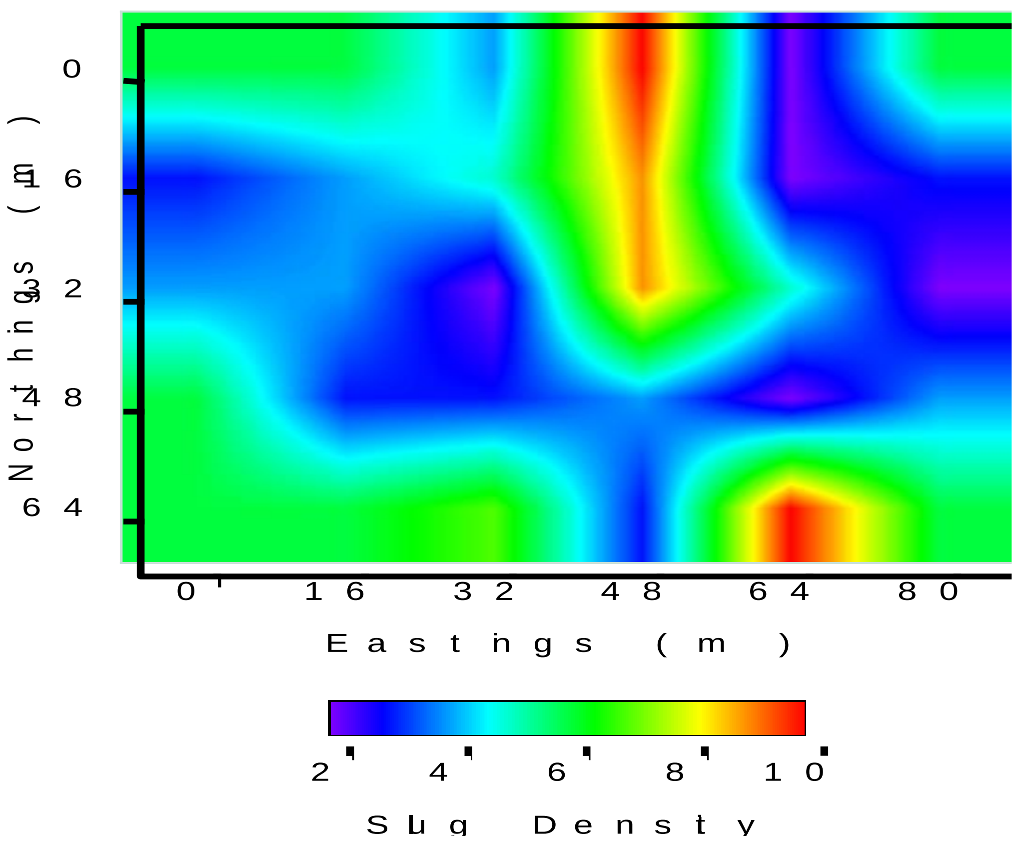
Crop	Threshold (average number of slugs/trap)
Winter cereal	4
Oilseed rape (standing cereals)	4
Oilseed rape (cereal stubble)	1
Potatoes	1
Field vegetables	1

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


We're All
DOOMED

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

Source: http://www.europarl.europa.eu/RegData/etudes/STUD/2018/627113/EPRS_STU(2018)627113_EN.pdf

SUD 1. Achieving prevention and suppression of harmful organisms

- 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

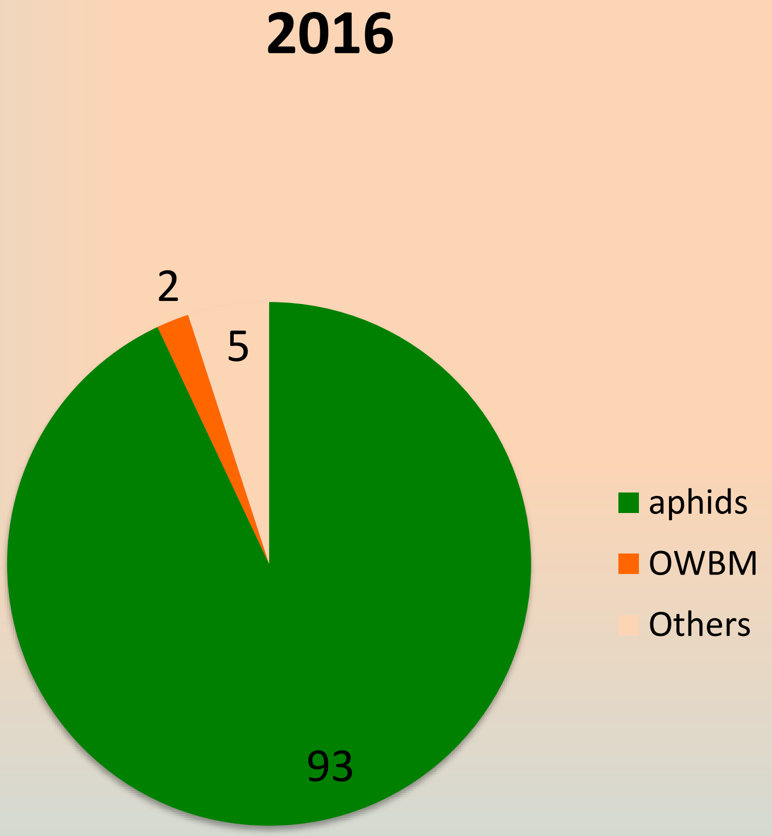
Pest of cereals in the UK

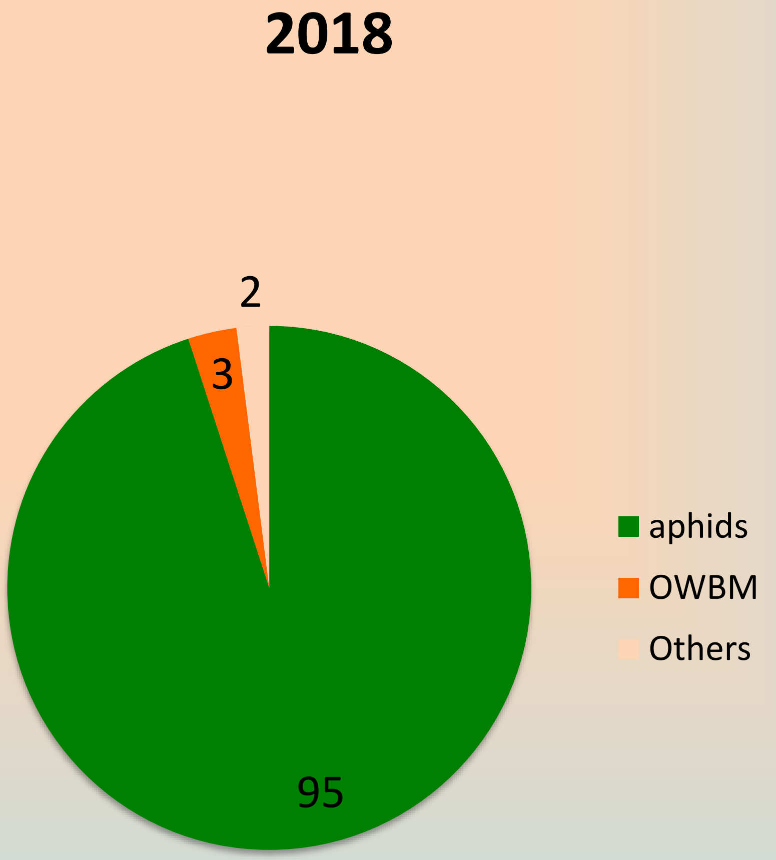
pest	species	Time of year
Grain aphids	*Sitobion avenae*	Autumn, BYDV, summer
Rose-grain aphids	*Metopolophium dirhodum*	summer
Bird-cherry aphids	*Rhopalosiphum padi*	Autumn, BYDV
Wheat bulb fly	*Delia coarctata*	winter
Gout fly	*Chlorops pumilionis*	Autumn, spring
Wheat orange blossom midge	*Sitodiplosis mosellana*	spring, summer
Saddle gall midge	*Haplodiplosis marginata*	summer

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

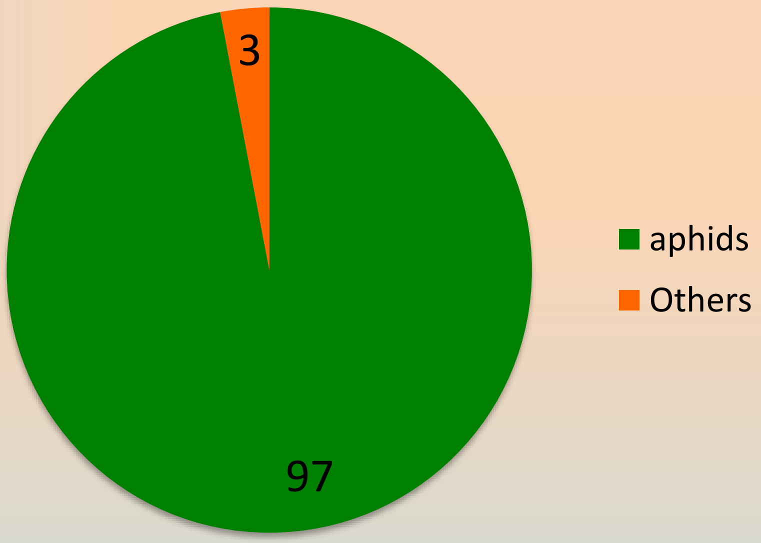




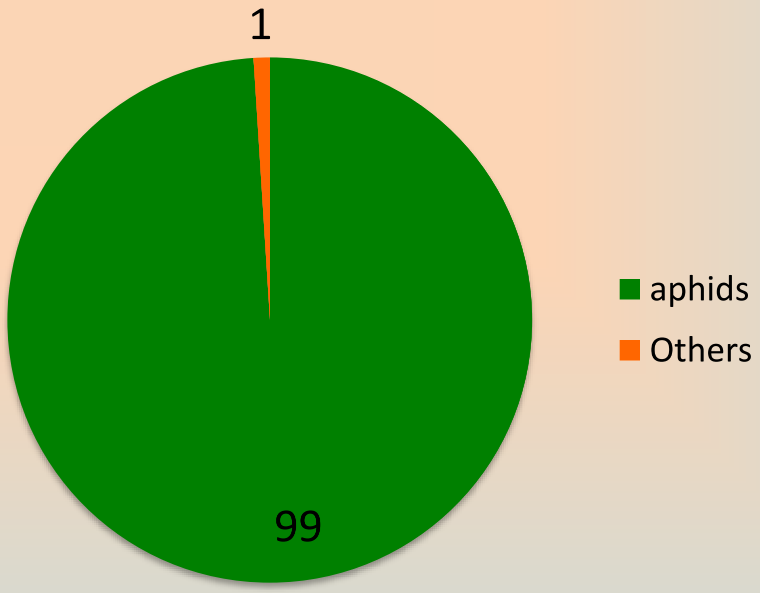
Source: Pesticide Usage Surveys in Arable Crops: Garthwaite *et al*., 2018 and 2019

Target pests for insecticides in winter barley in the UK

2016



2018



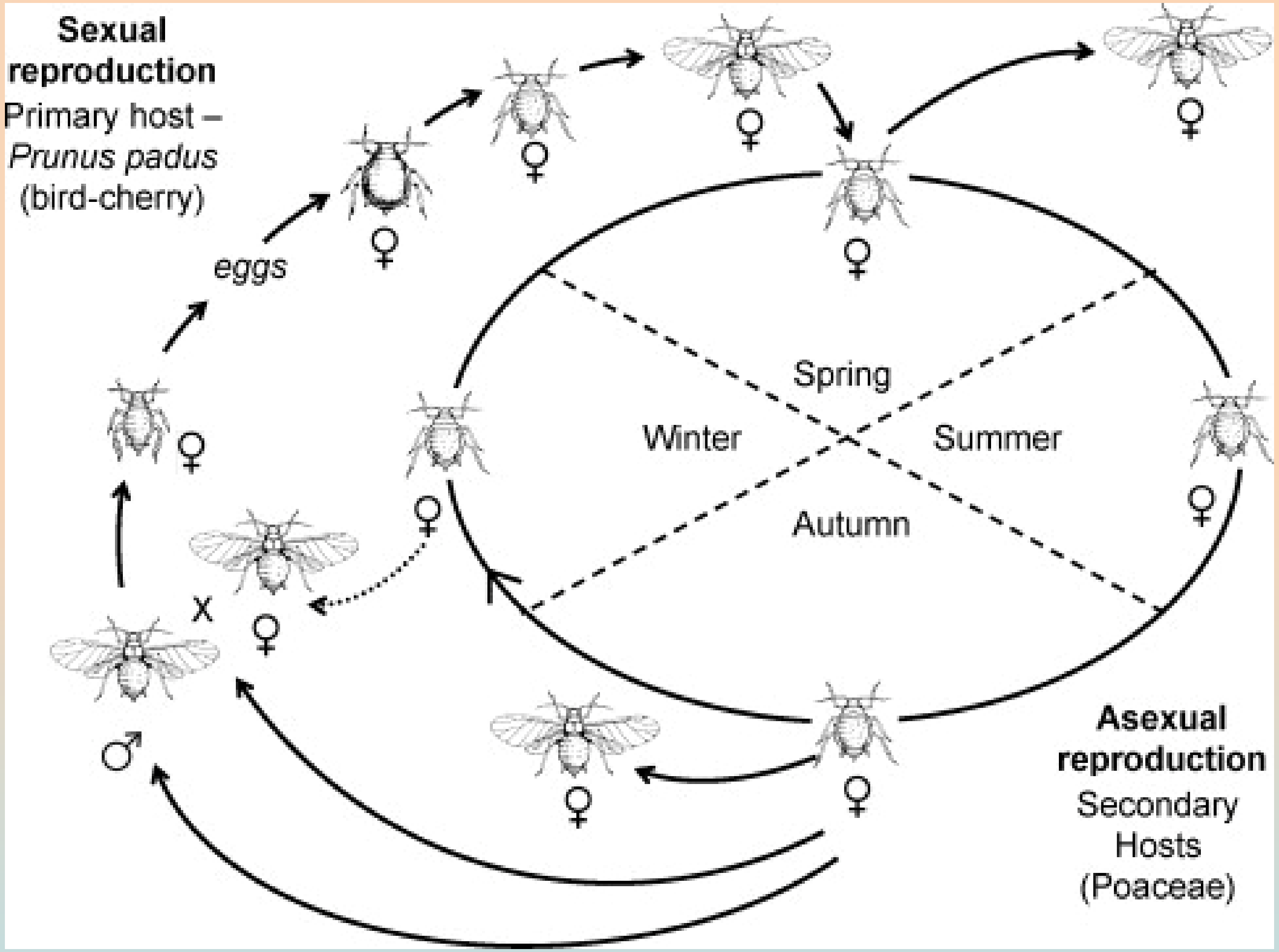
Source: Pesticide Usage Surveys in Arable Crops: Garthwaite *et al*., 2018 and 2019

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 pyrethropid resistant/tolerant clone of *R padi* has recently been recorded in Ireland, so watch this space

Life cycle of *R. padi*



It is the asexual forms which are the main vectors of BYDV in cereals

The grain aphid, *Sitobion avenae*

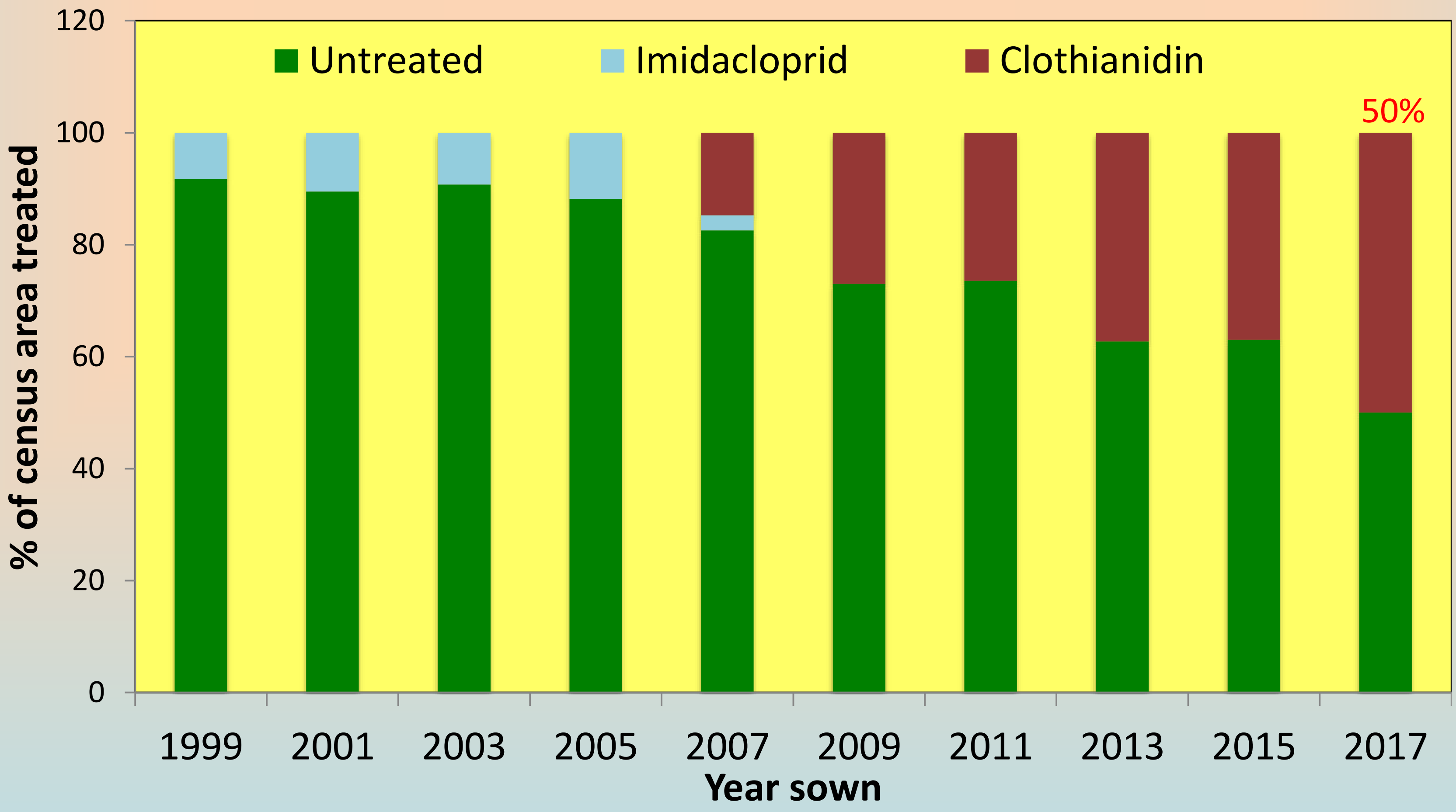
- Important pest on wheat, barley and oats
- Can reduce grain yield
- Transmits BYDV - MAV and PAV strains
- Previous good control with Deter and pyrethroids
- Control failures reported in summer 2011 and springs of 2012 and 2016

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

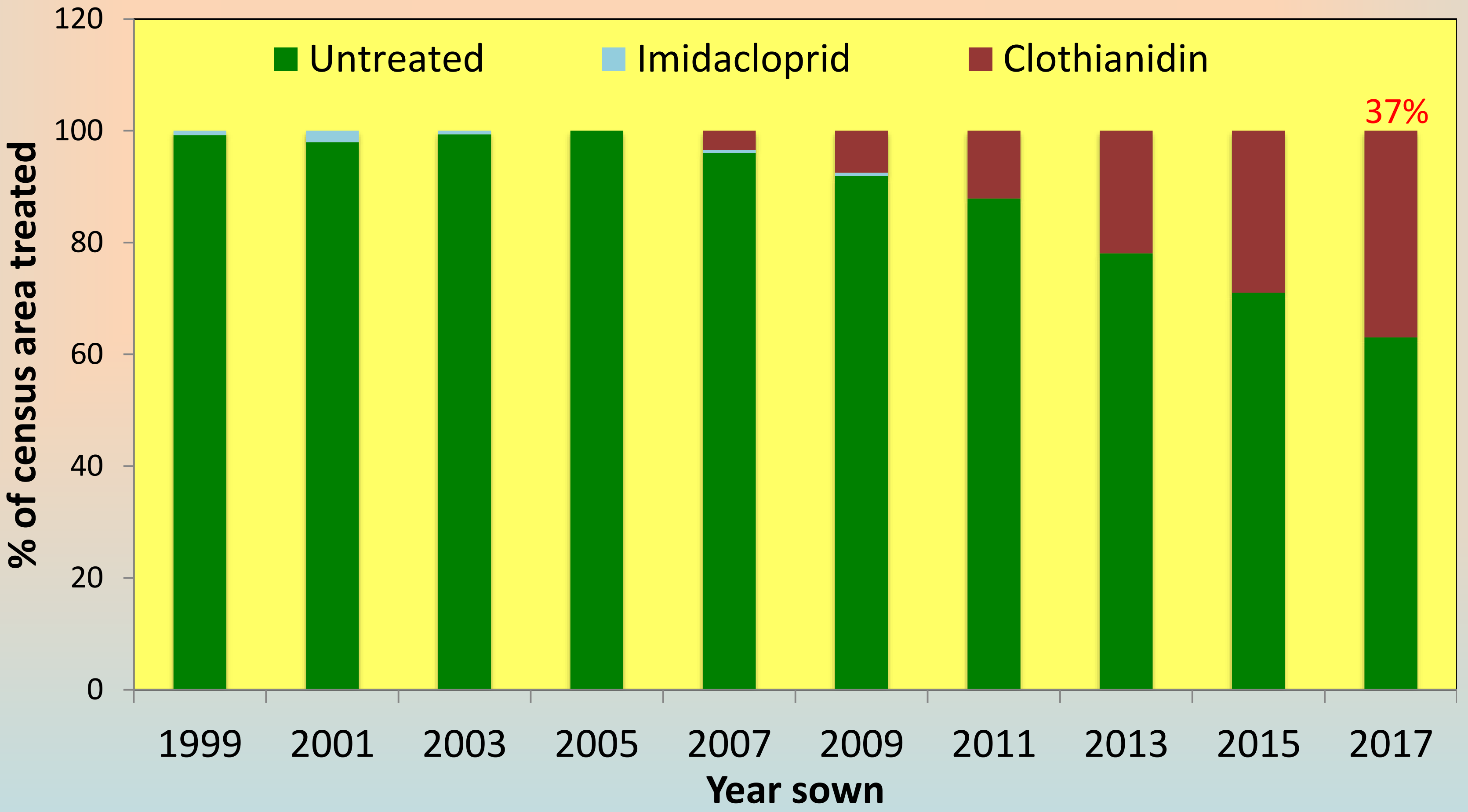
These epidemics have often been associated with the presence of grain aphids, NOT bird cherry aphids

Use of neonicotinoid seed treatments in winter and spring wheat in GB: 1999-2018



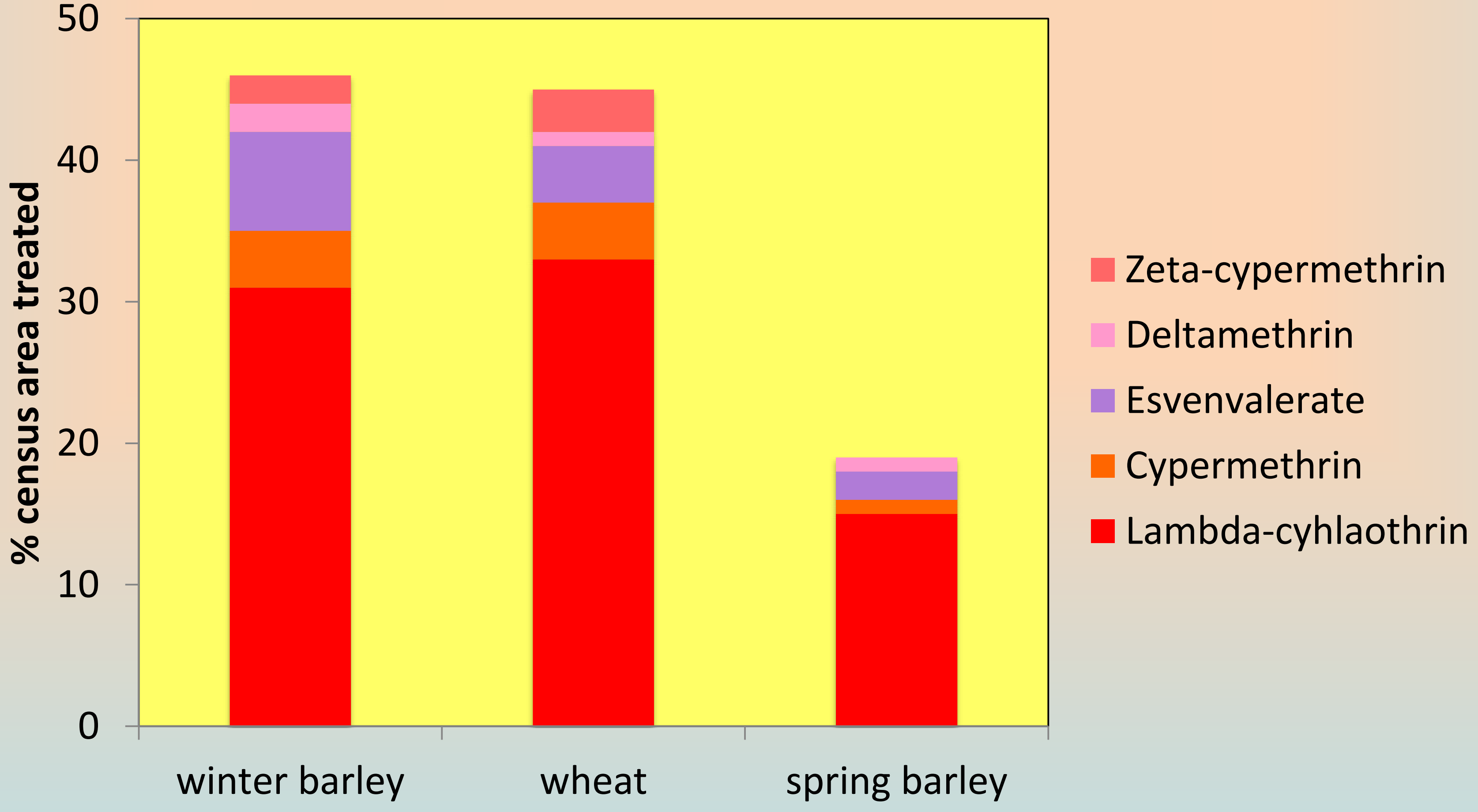
Source:
Pesticide Usage Survey Reports: Garthwaite *et al*., 2001, 2003, 2005, 2007, 2009, 2011, 2013, 2015 , 2018, 2019

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



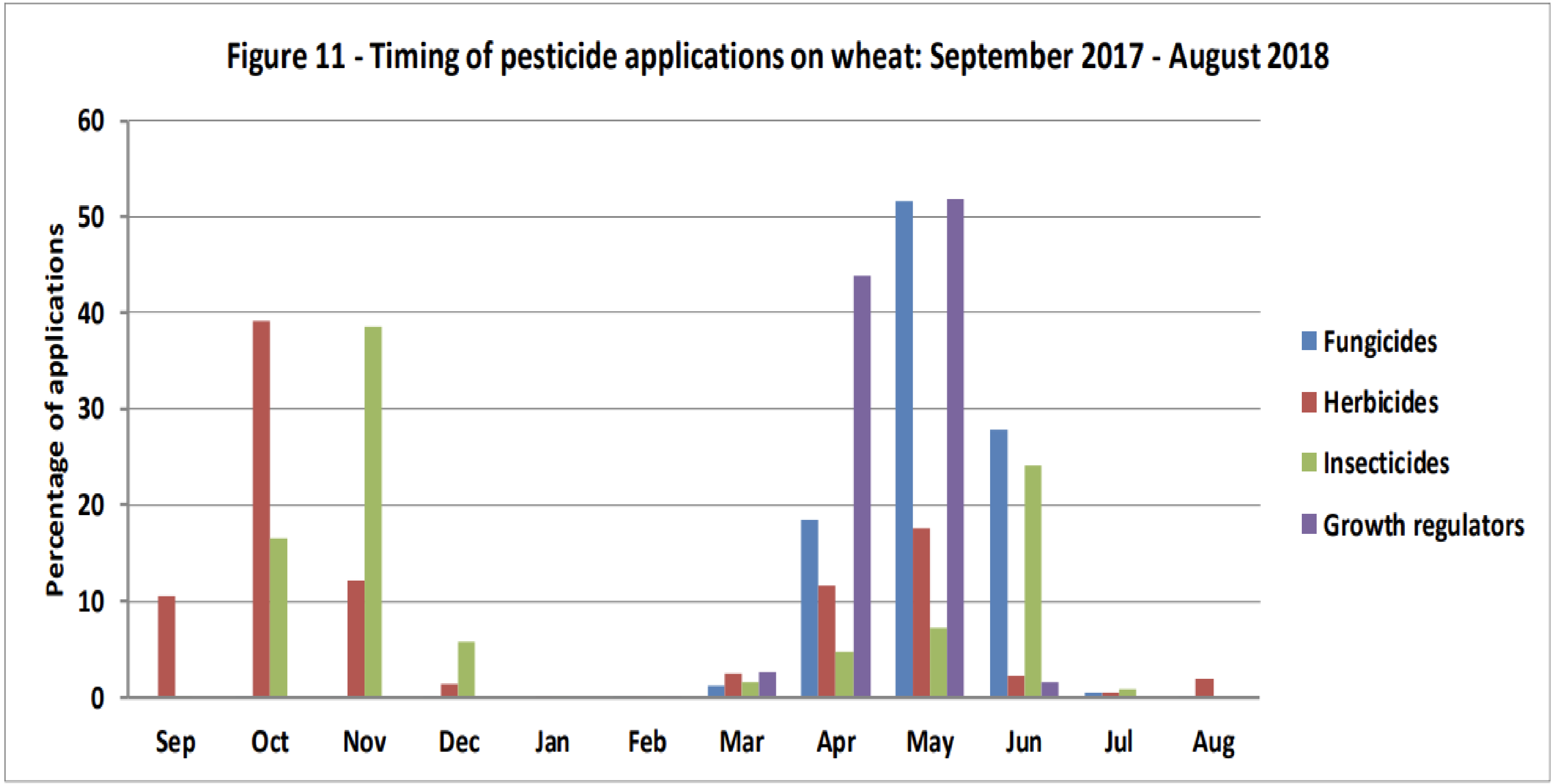
Source:
Pesticide Usage Survey Reports: Garthwaite *et al.*, 2001, 2003, 2005, 2007, 2009, 2011, 2013, 2015, 2018, 2019

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



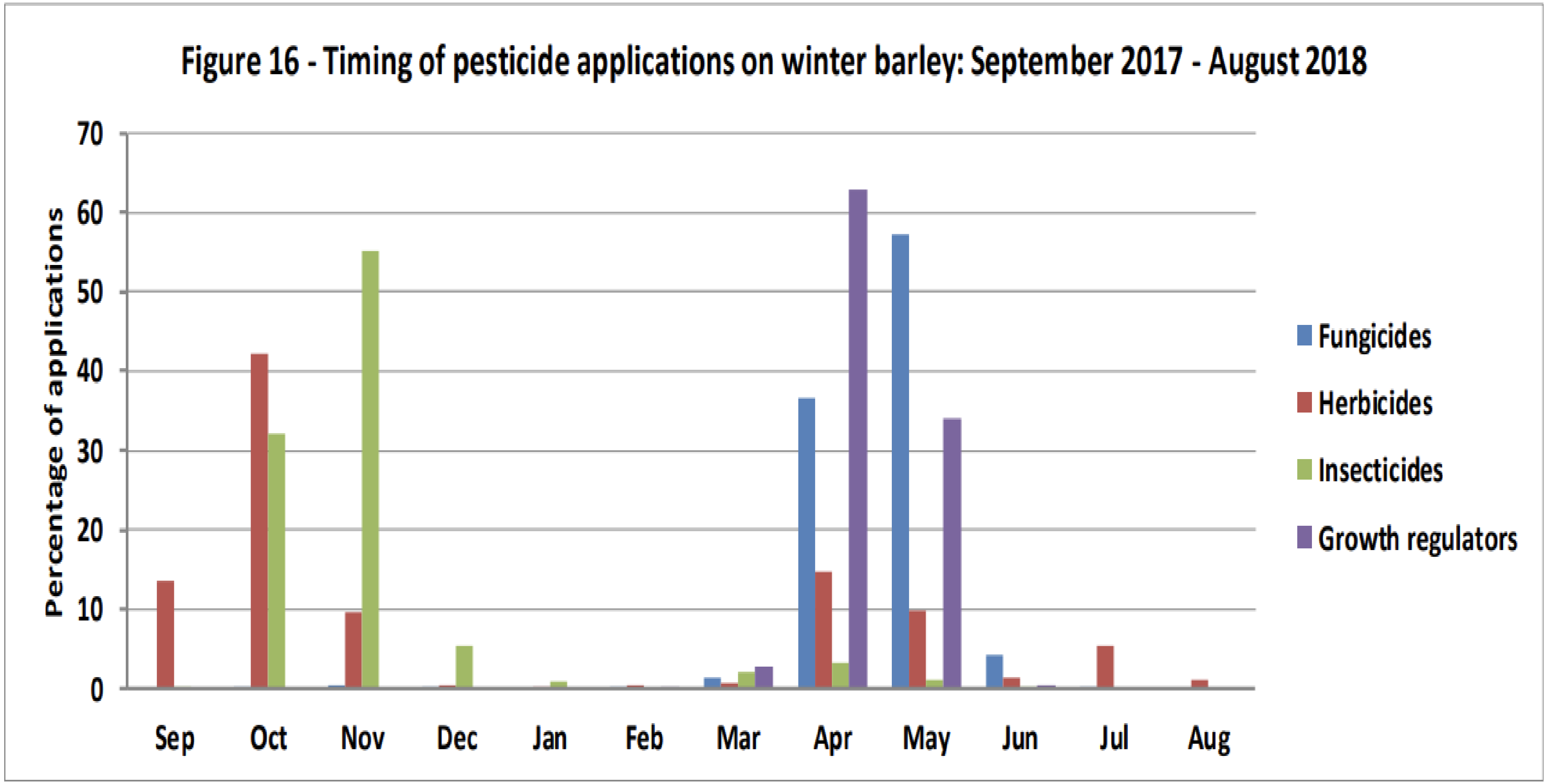
Source: Pesticide Usage Survey, Report 284: Garthwaite *et al.*, 2019

Target pests for insecticides in winter wheat in the UK 2017-2018



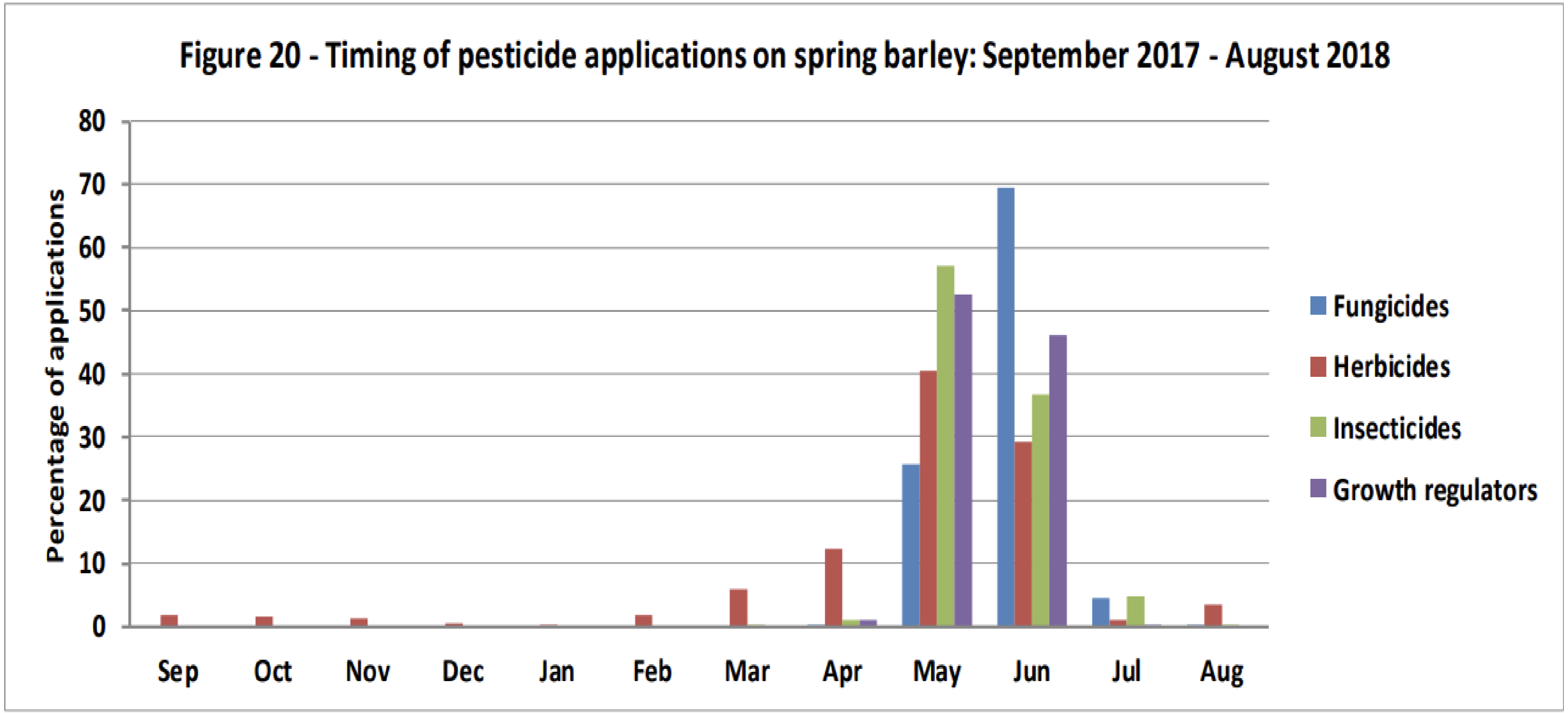
Source: Pesticide Usage Survey in Arable Crops, 284: Garthwaite *et al.*, 2019

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

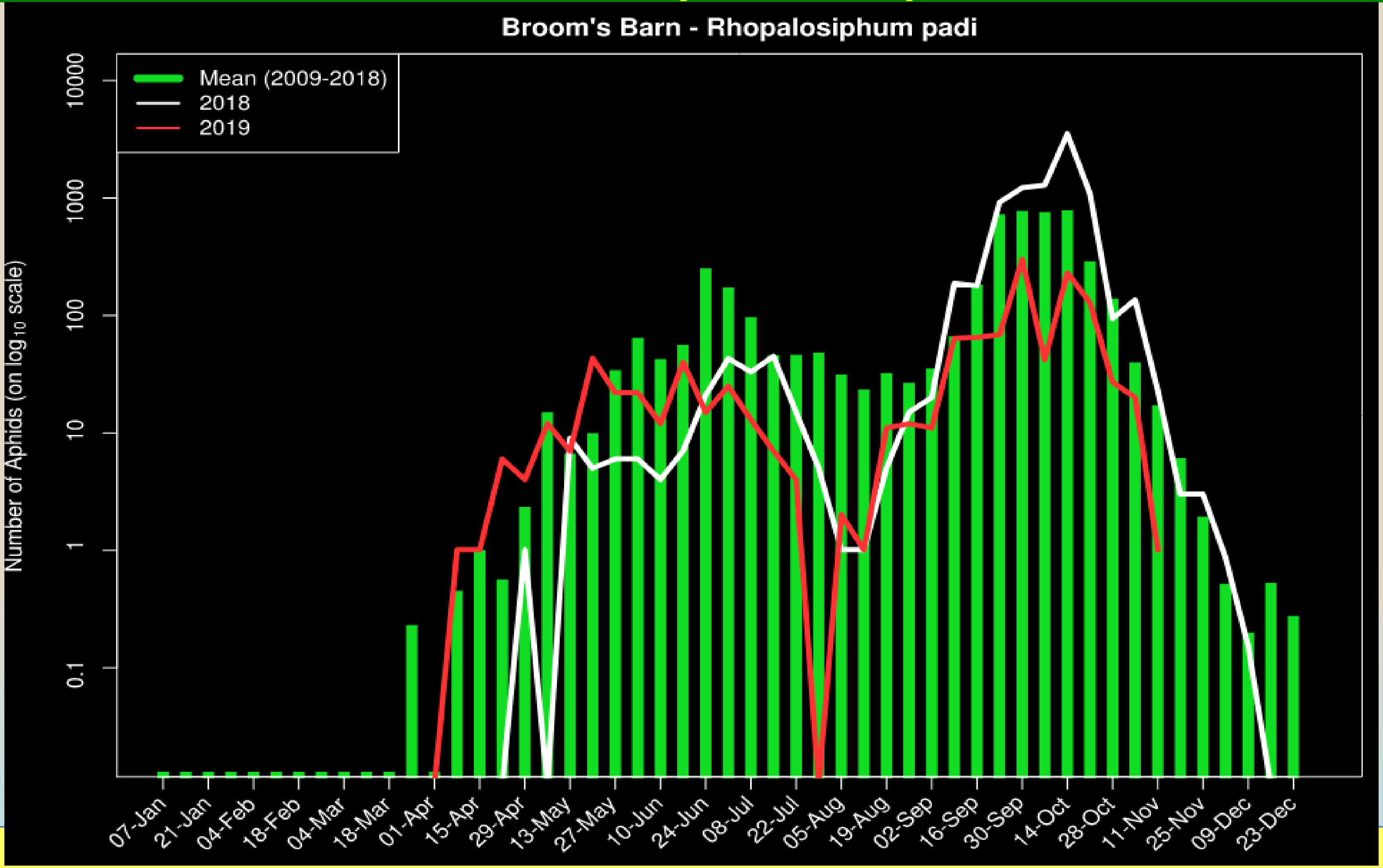
SUD 2. Monitoring of harmful organisms

- 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

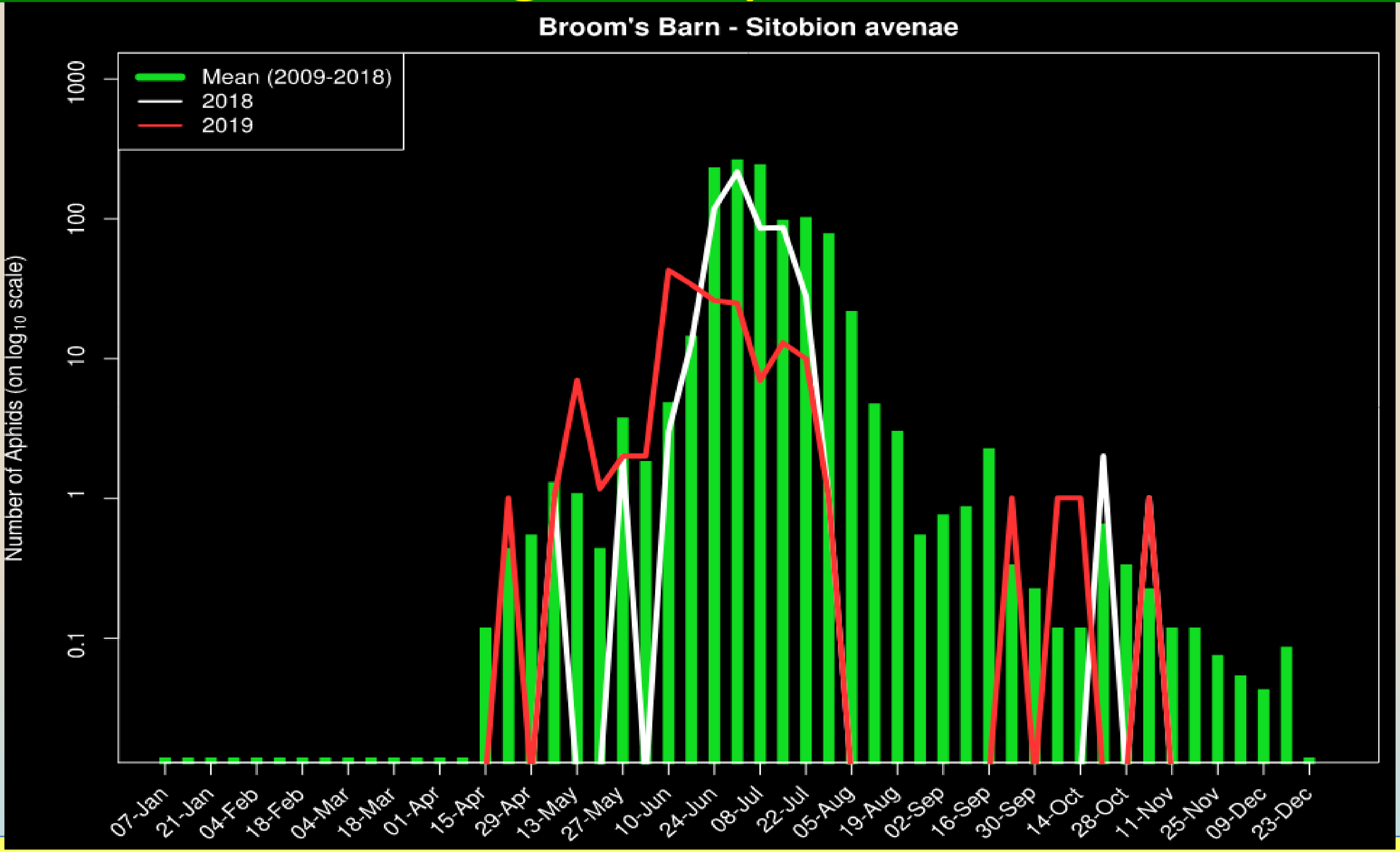
Rothamsted Insect Survey suction trap sites

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

Yellow water trap

Insect soup

Sticky trap

These do require the skills of an entomologist

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?

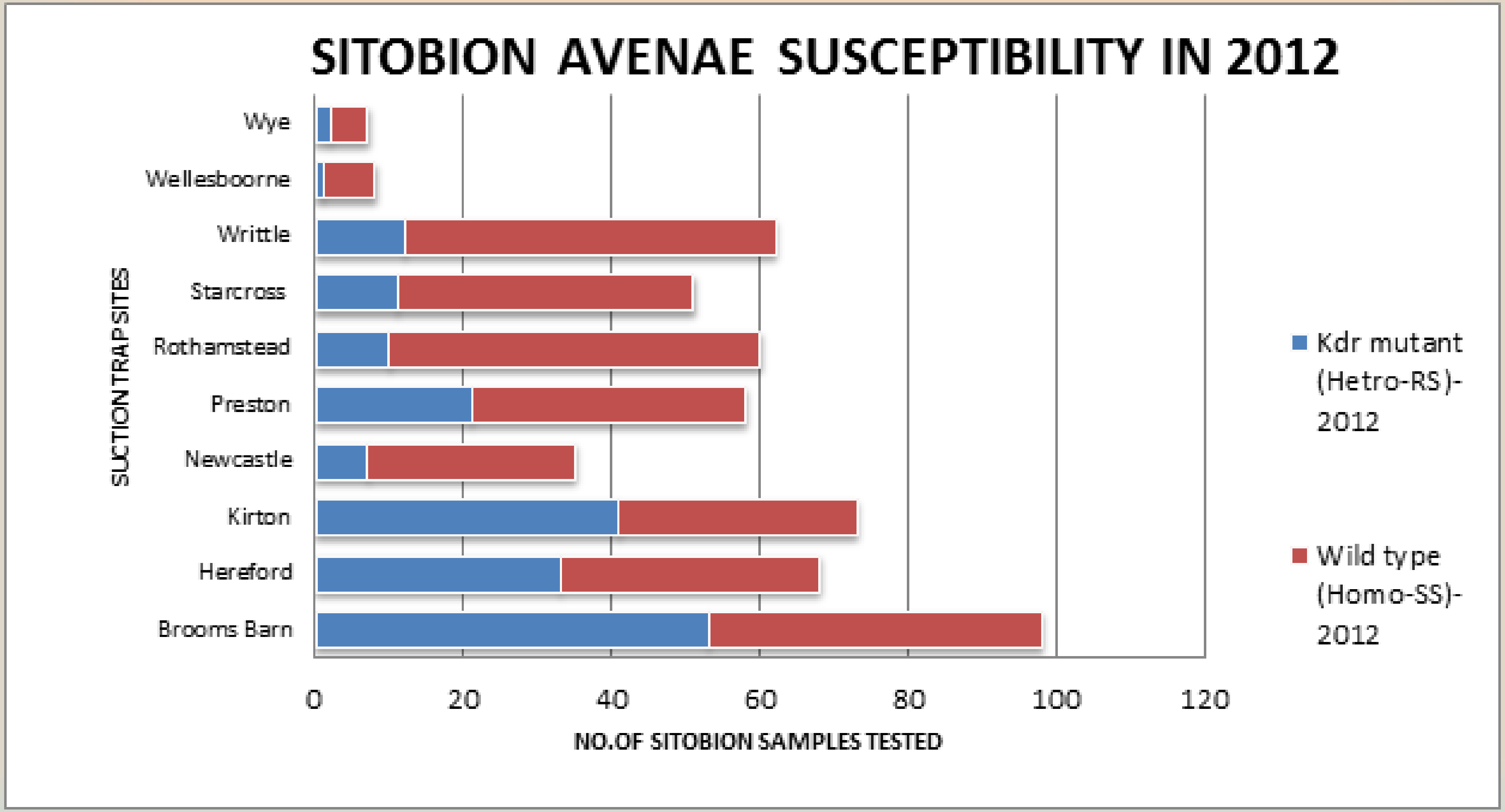
SUD 3. Decisions made based on monitoring and thresholds (2)

- 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

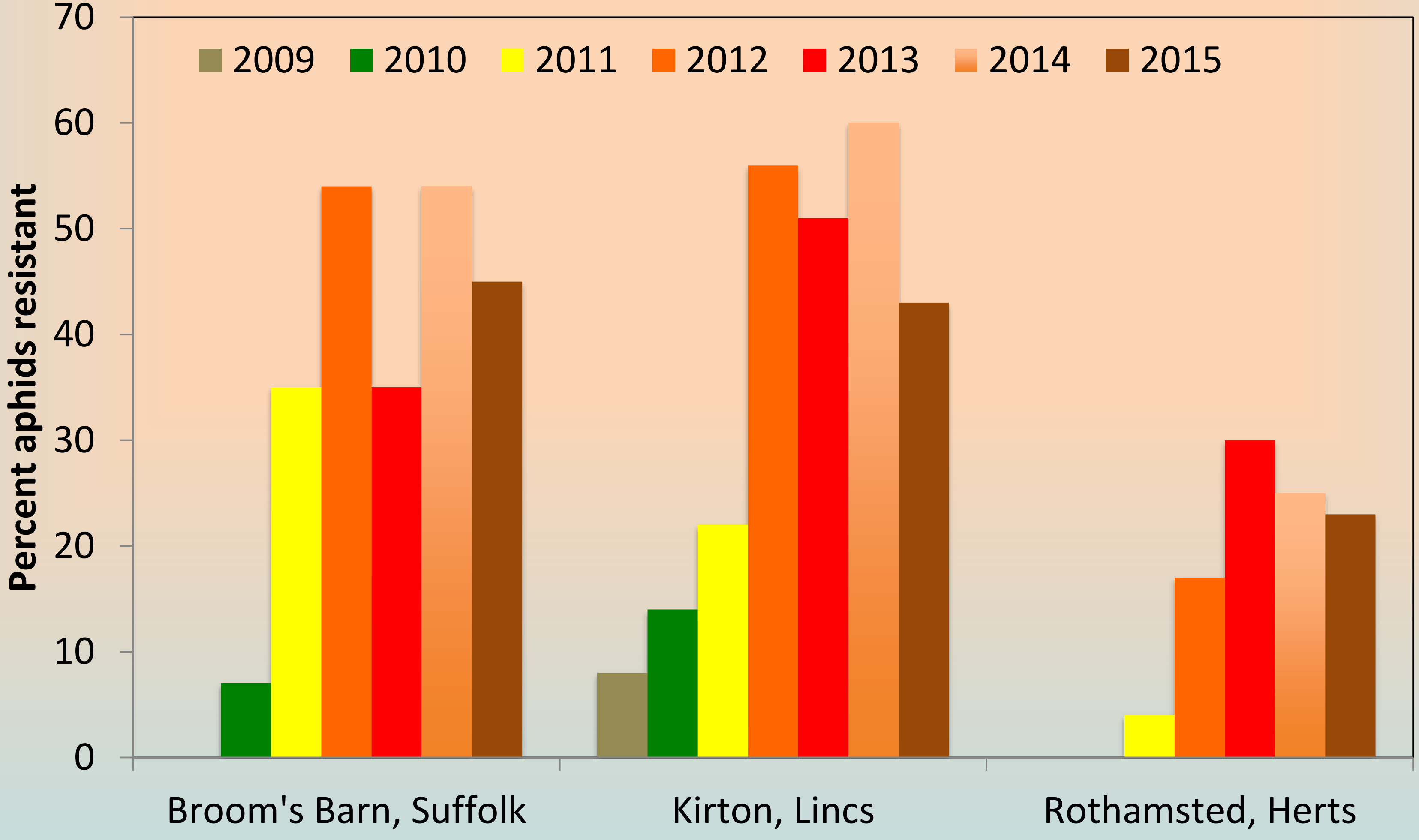
Survey funded by Syngenta Crop Protection

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

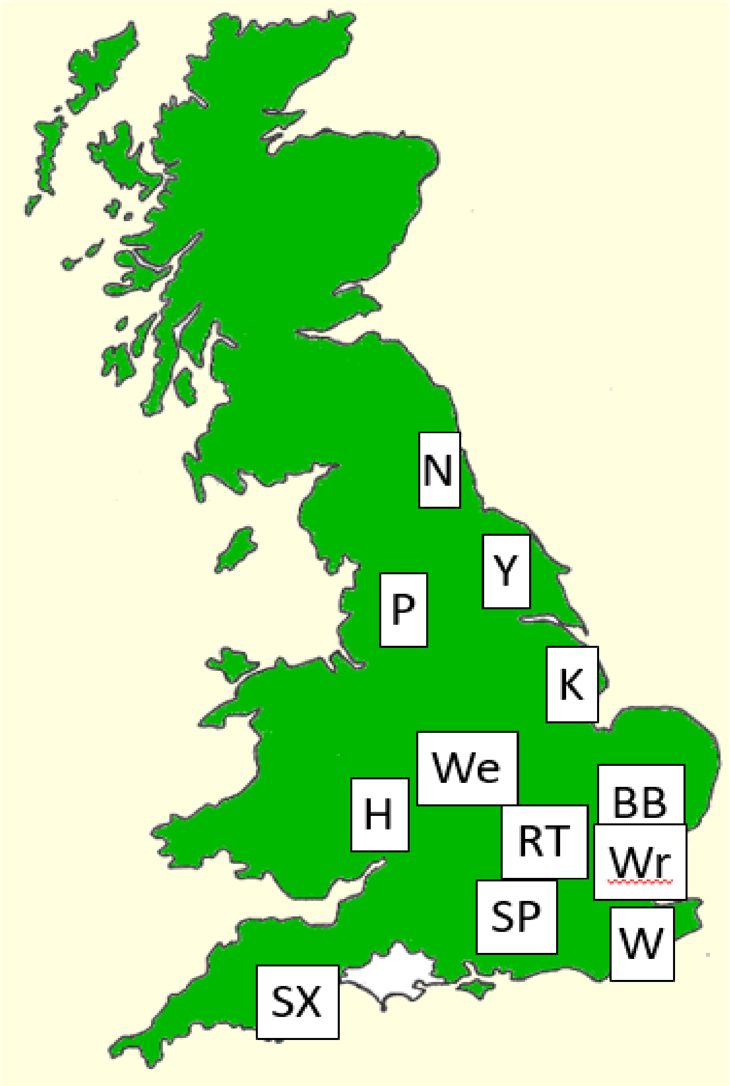


Rothamsted not tested in 2009 and 2010; lack of funding has prevented more recent surveys

BYDV incidence / suction trapped *R. padi* October 2018

Pilot study: <100 aphids tested / trap

Trap	R padi	% BYDV
N	625	18
Y	15808	12
P	15995	15
K	11887	3
BB	8696	13
We	6929	6
H	6445	3
RT	3734	0
Wr	10471	21
SP	2752	4
W	6406	8
SX	3971	8

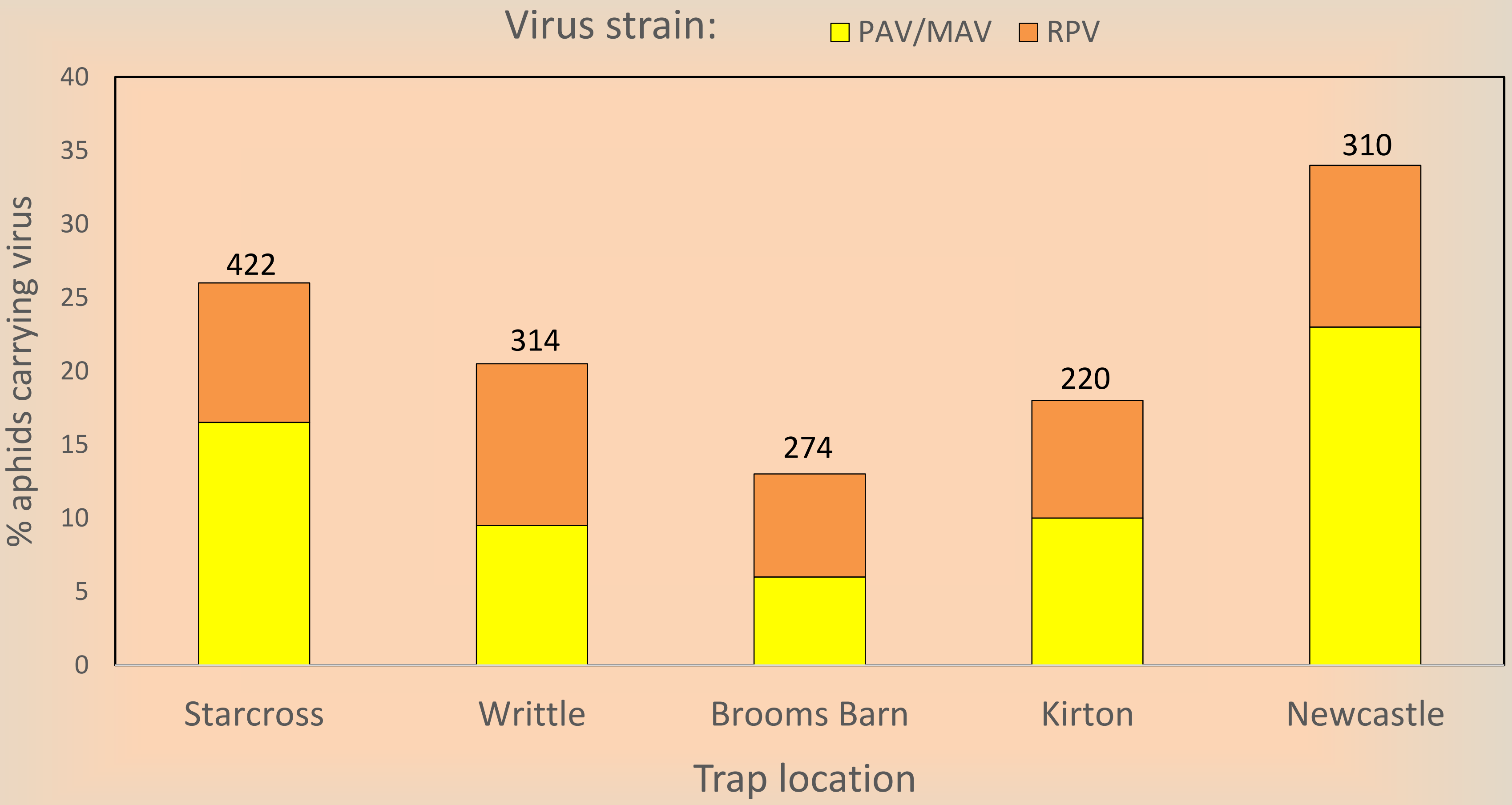


Insect Survey network: Newcastle, York, Kirton, Wellesbourne, Hereford, Rothamsted, Brooms Barn, Writtle, Silwood Park, Wye & Starcross)

Source: Martin Williamson at Rothamsted Research

ROTHAMSTED RESEARCH

Percentage *R. padi* carrying BYDV (PAV and MAV) and CYDV-RPV across five English suction traps in autumn 2019



Number tested above columns

ROTHAMSTED RESEARCH

Source: Martin Williamson at Rothamsted Research

AHDB AGRICULTURE & HORTICULTURE DEVELOPMENT BOARD

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

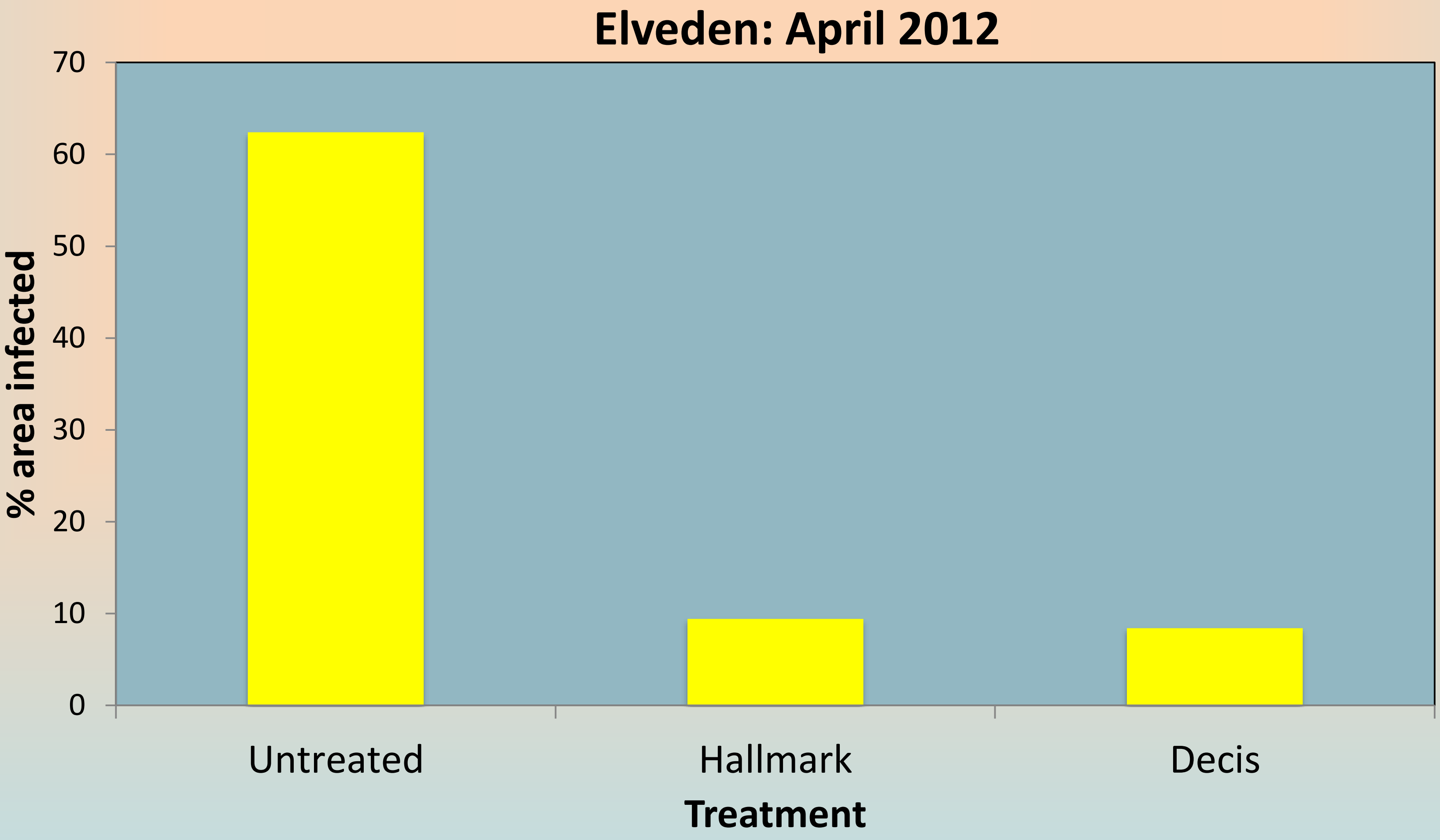
- Some varieties now coming through development
  - Amistar (KWS) and Rafaela (LG Seeds) in winter barley
  - Wolverine (RAGT) in winter wheat

Right photo courtesy of Hugo Ellis of NIAB

SUD 5 Pesticide Selection

- 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

Efficacy of insecticides against BYDV in winter barley 2011-2012



Both treatments gave significant control of the vector *R padi*

Effect of pyrethroids on BYDV infection spread by bird-cherry aphids

Untreated Treated

SUD 6 Reduced Use

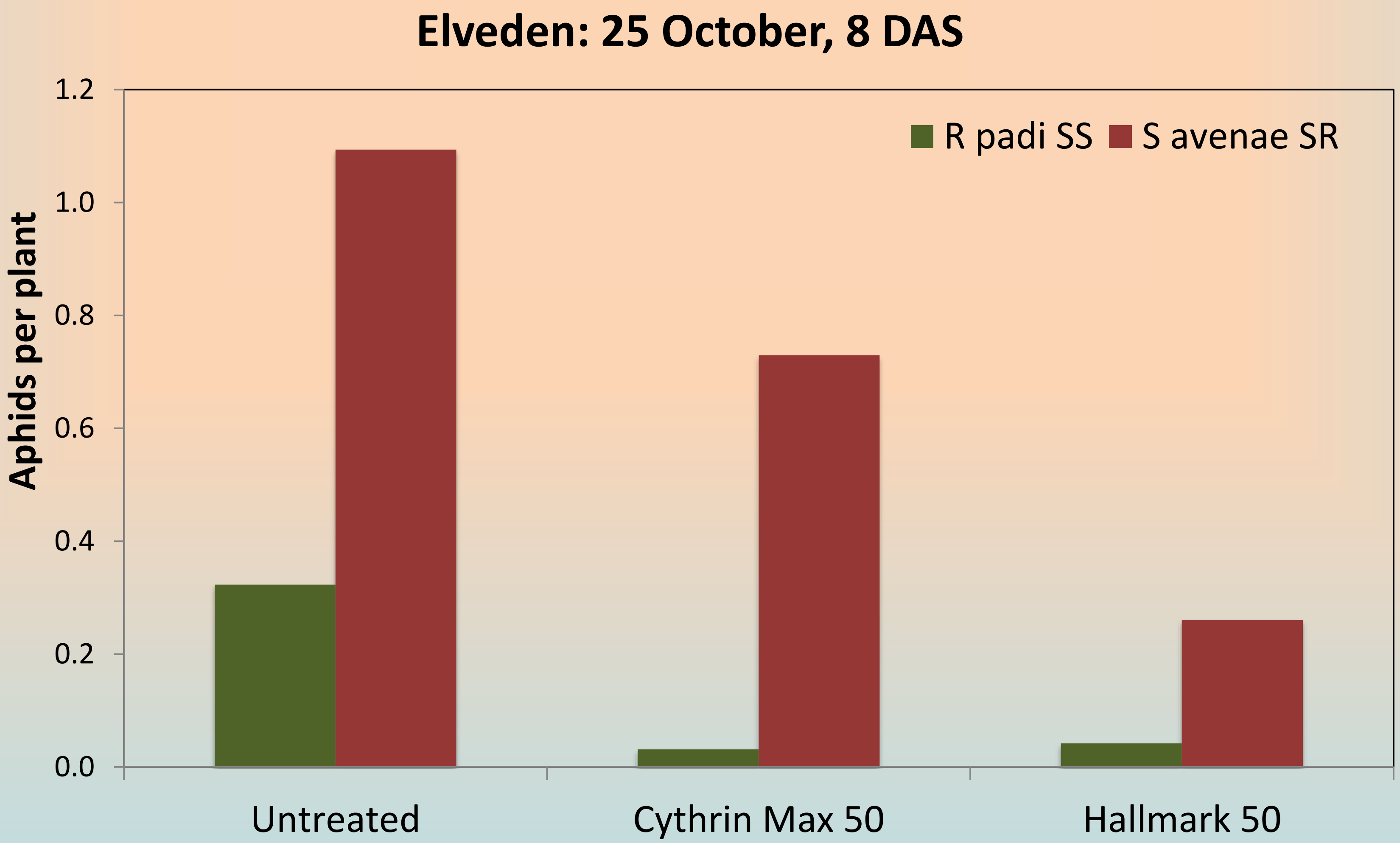
- In absence of effective seed treatments use of pyrethroids is likely **to increase** significantly
  - perhaps **double** the previous use?
  - although perhaps not this year given the inclement weather
- **This is likely to lead to selection for resistance**

SUD 7. Anti-resistance strategies

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

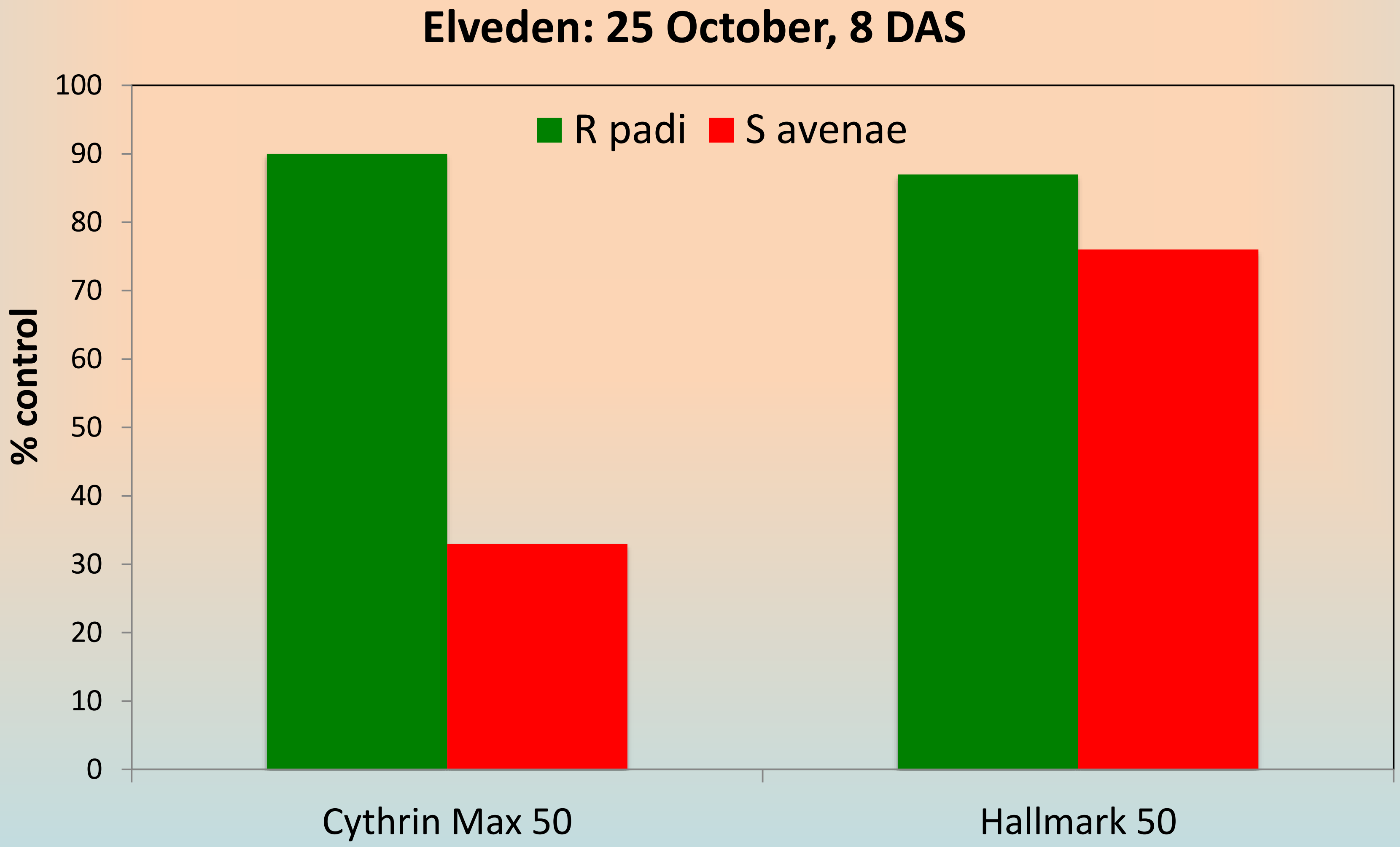
2. And higher risk of selection for resistance in *Rhopalosiphum padi*

Efficacy of insecticides in winter barley against aphids in 2016



aphids inoculated on 14 October; sprays applied on 17 October

Efficacy of insecticides in winter barley against aphids in 2016

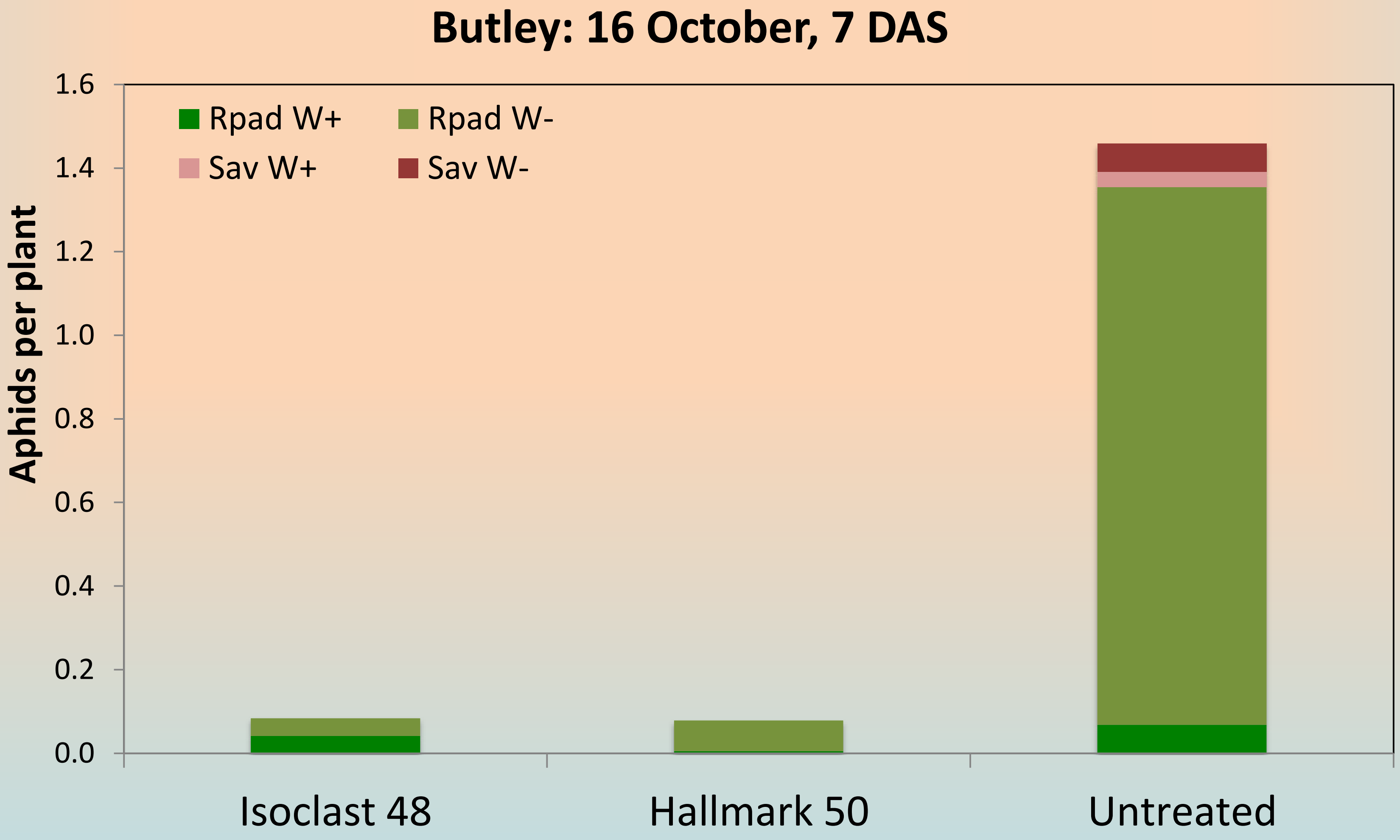


aphids inoculated on 14 October; sprays applied on 17 October:

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



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

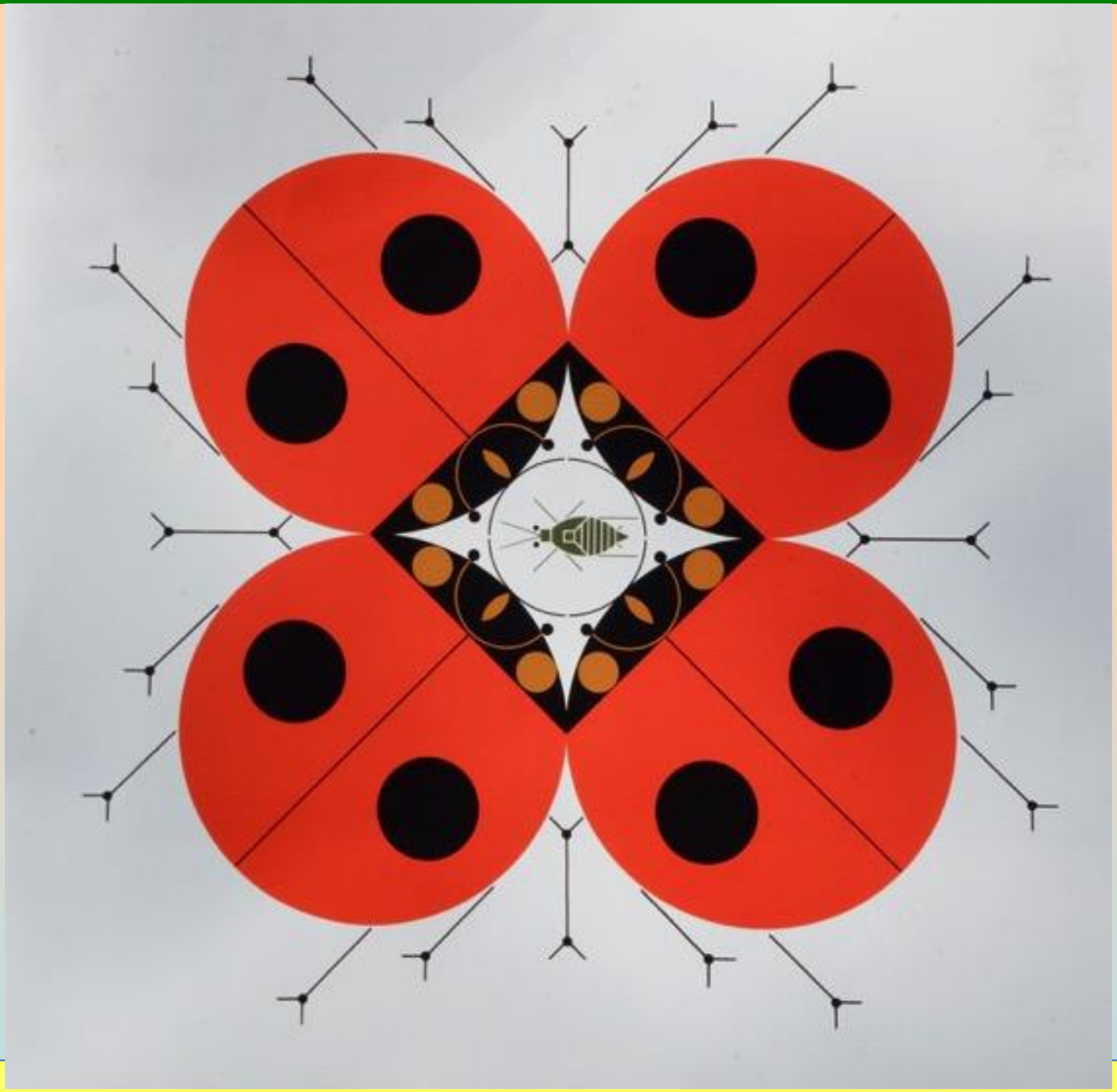
SUD 8 Evaluation

- Surveys of use of pesticides (already done though 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

AHDB

AHDB Agronomists' Conference 2019

Session Two – Crop nutrition in cereals & oilseeds

Fostering Populations Of Arbuscular Mycorrhizal Fungi Through Cover Crop Choices and Soil Management

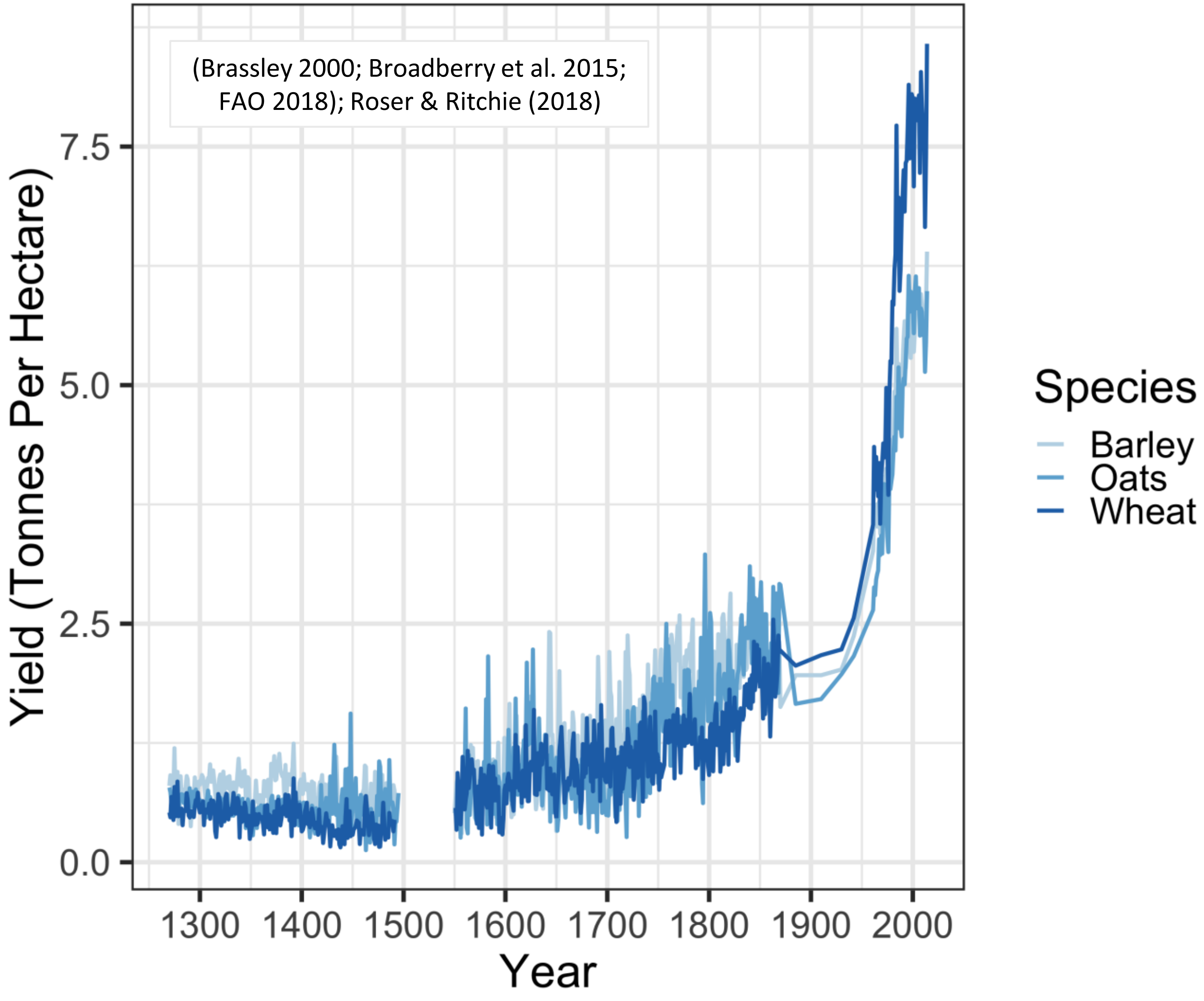
George Crane

Department of Plant Sciences/ NIAB

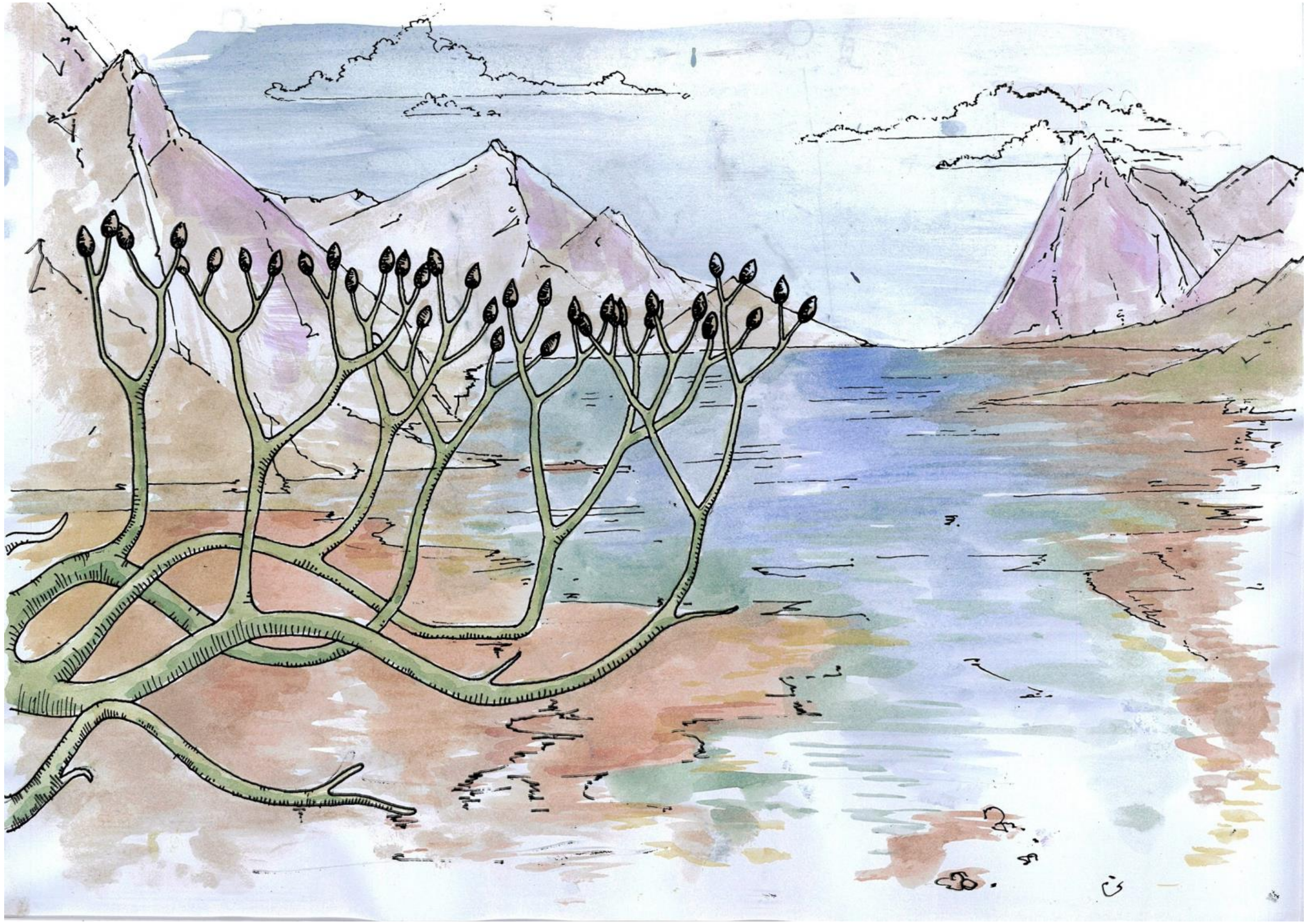
The Problem with Food Production

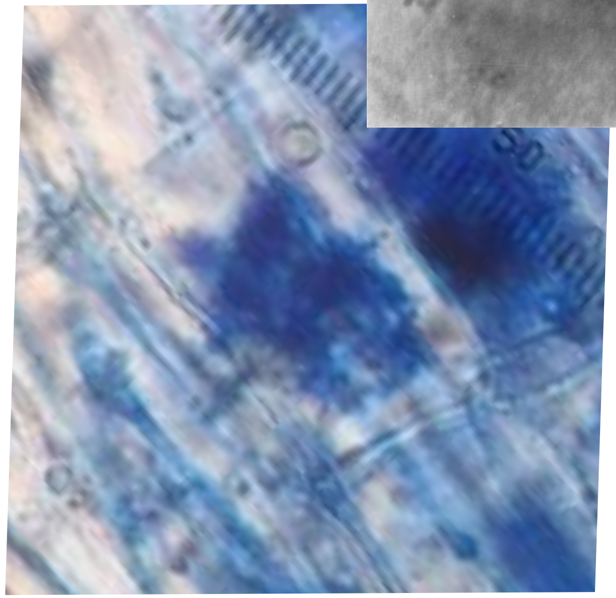
- Since the 1960s
  - **Incredible yield increase!** But..
  - 7.5 times more nitrogen fertiliser
  - 3.3 times more phosphorus fertiliser
  - Degradation of soils

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



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

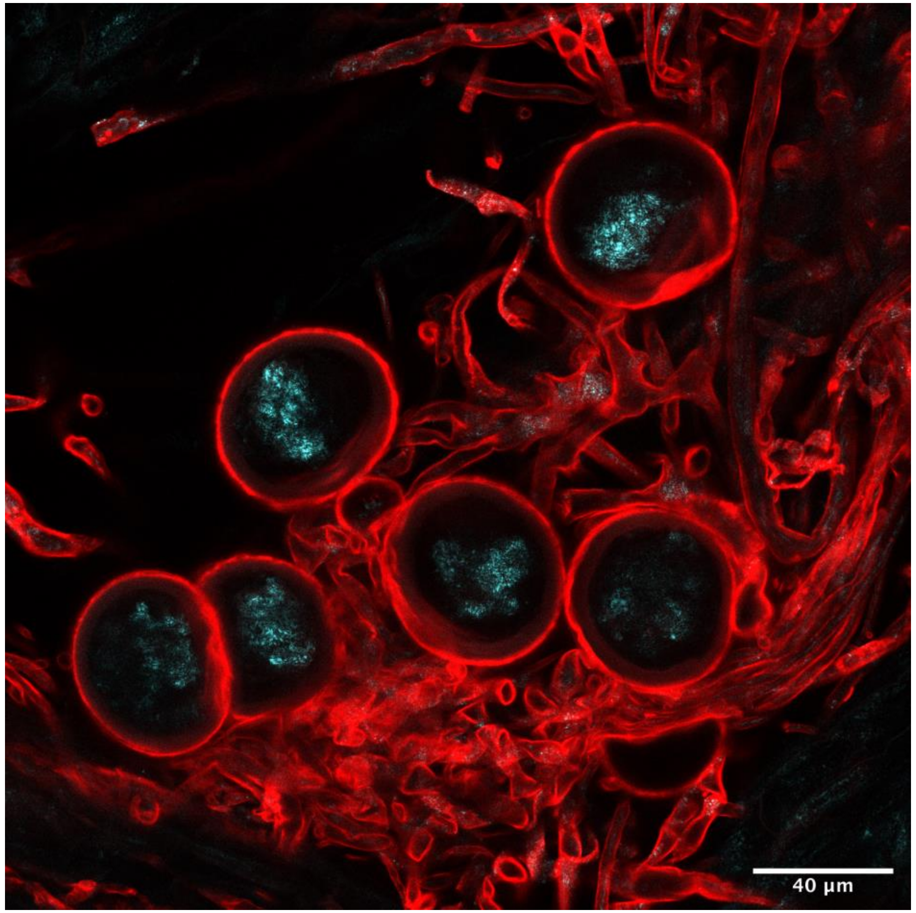
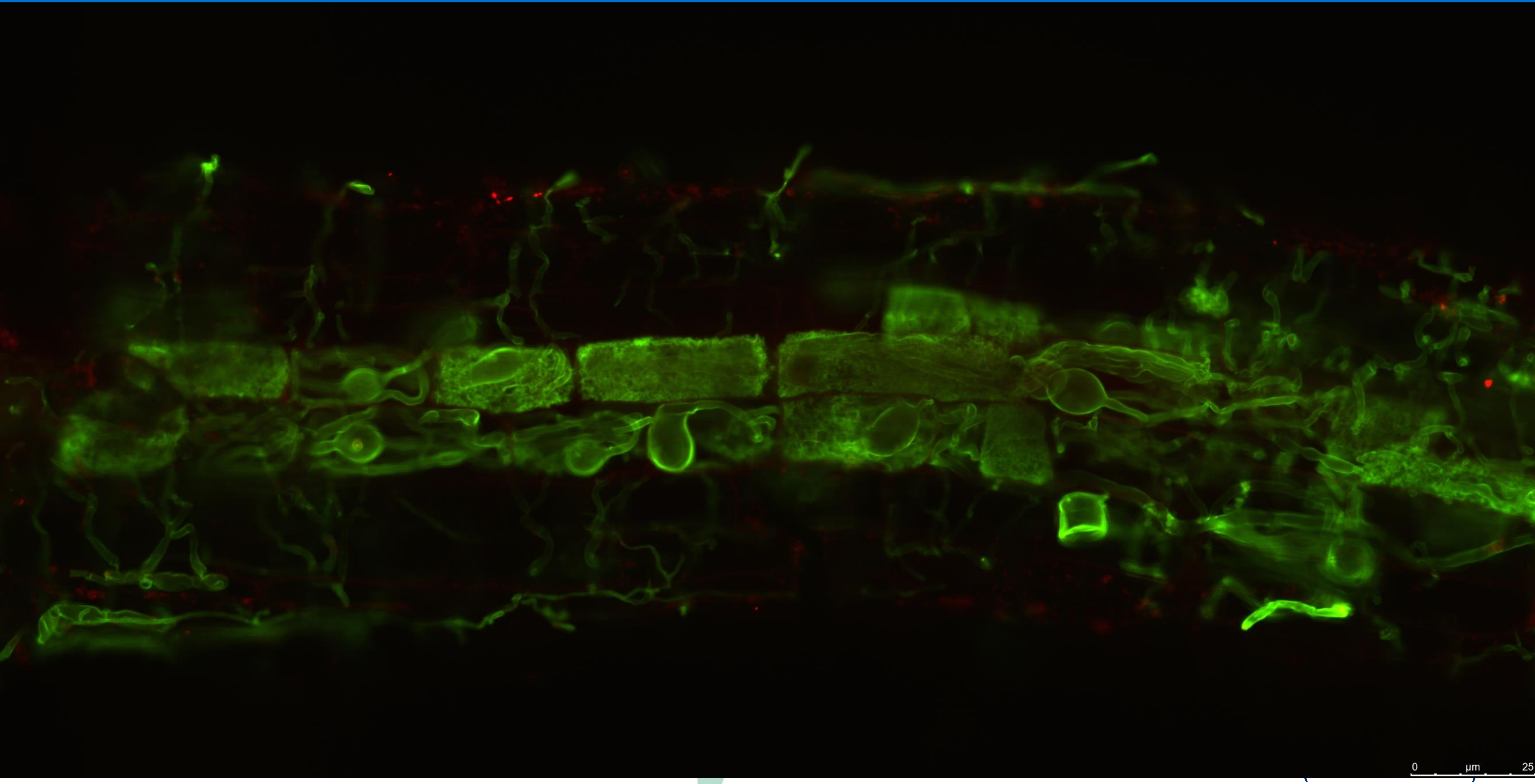


Image: Mieke Jürgens

(Van Geel *et al.* 2016, Lekberg and Koide 2005)


0
µm
25

PhD Hypotheses

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

Current Projects

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

AHDB AFCP The AgriFood Charities Partnership Agri-Tech East Allpress INNOVATIVE FARMERS PART OF THE DUCHY FUTURE FARMING PROGRAMME Plant Works