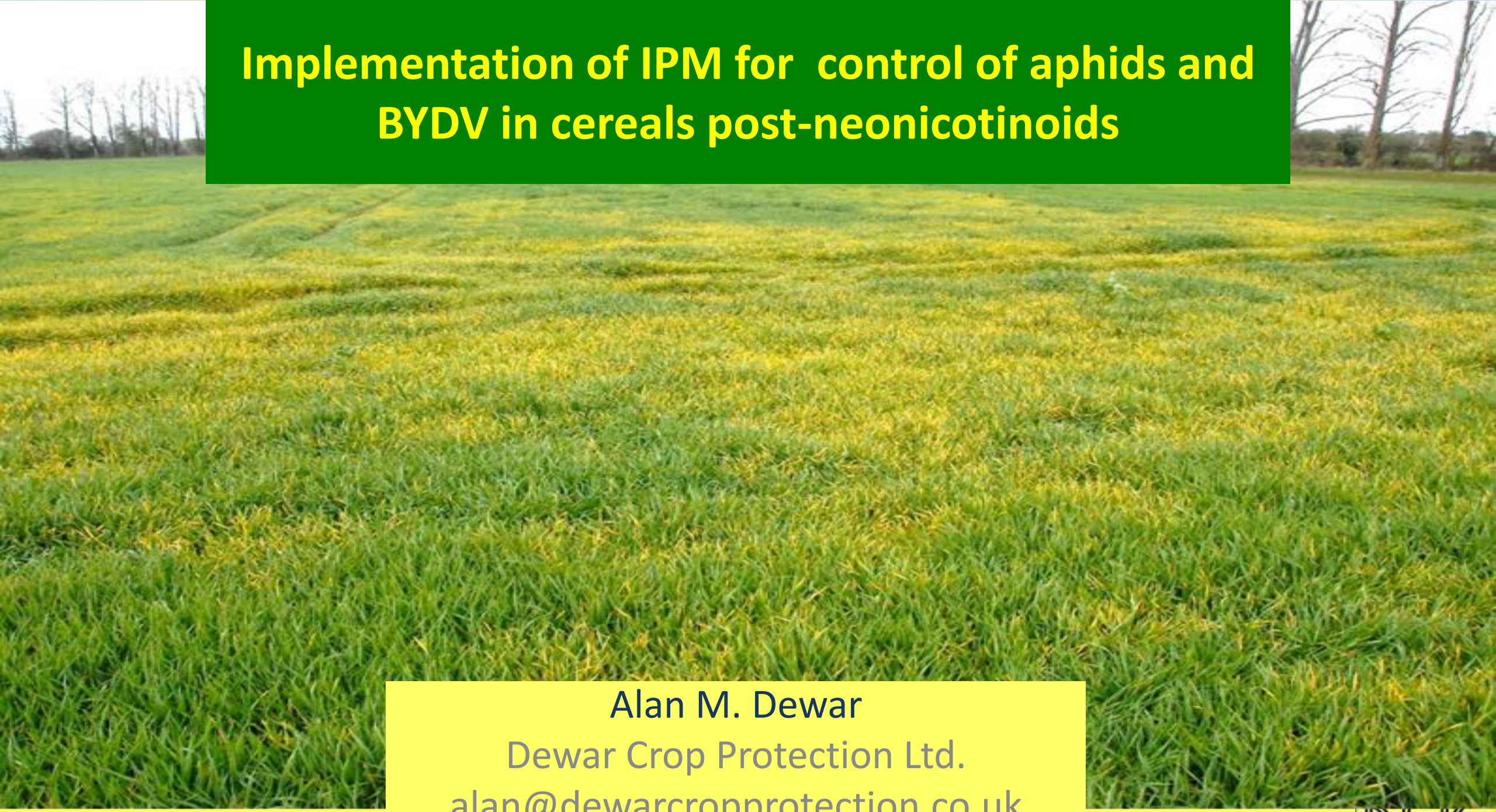
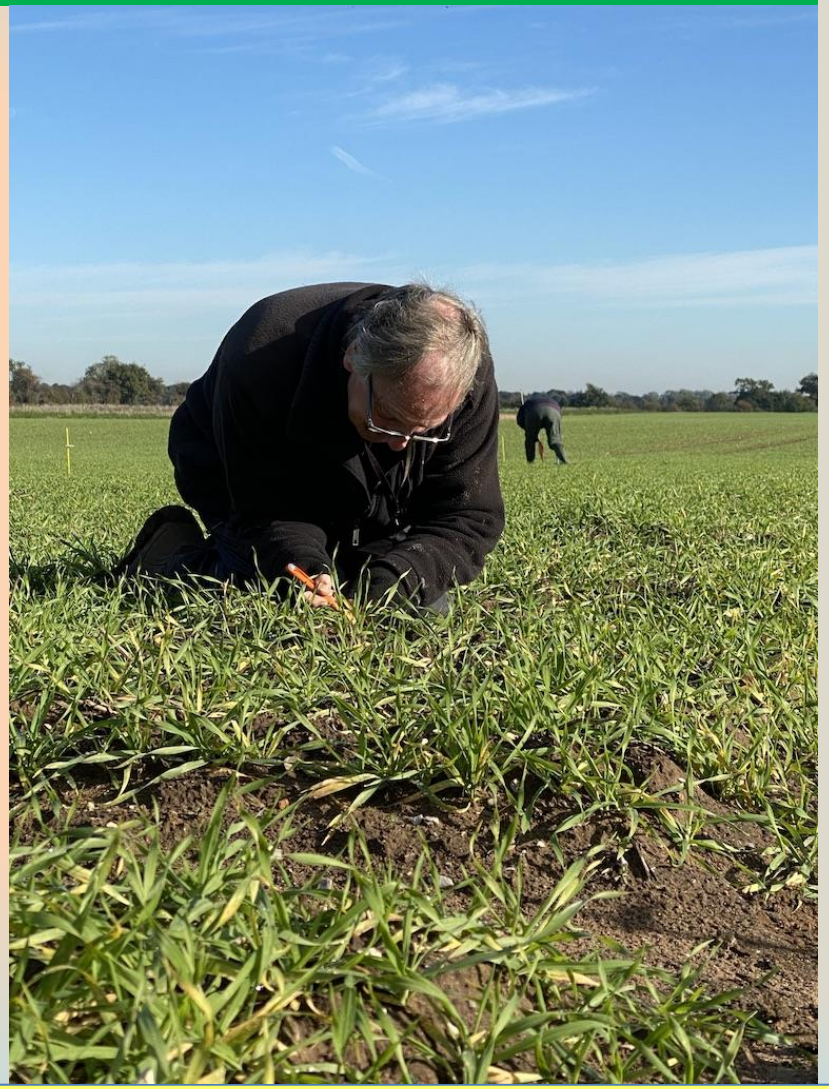
Implementation of IPM for control of aphids and BYDV in cereals post-neonicotinoids



Alan M. Dewar
Dewar Crop Protection Ltd.
alan@dewarcropprotection.co.uk

45 years of cereal aphid research
Then and now



Sustainable Use Directive principles on Integrated Pest Management

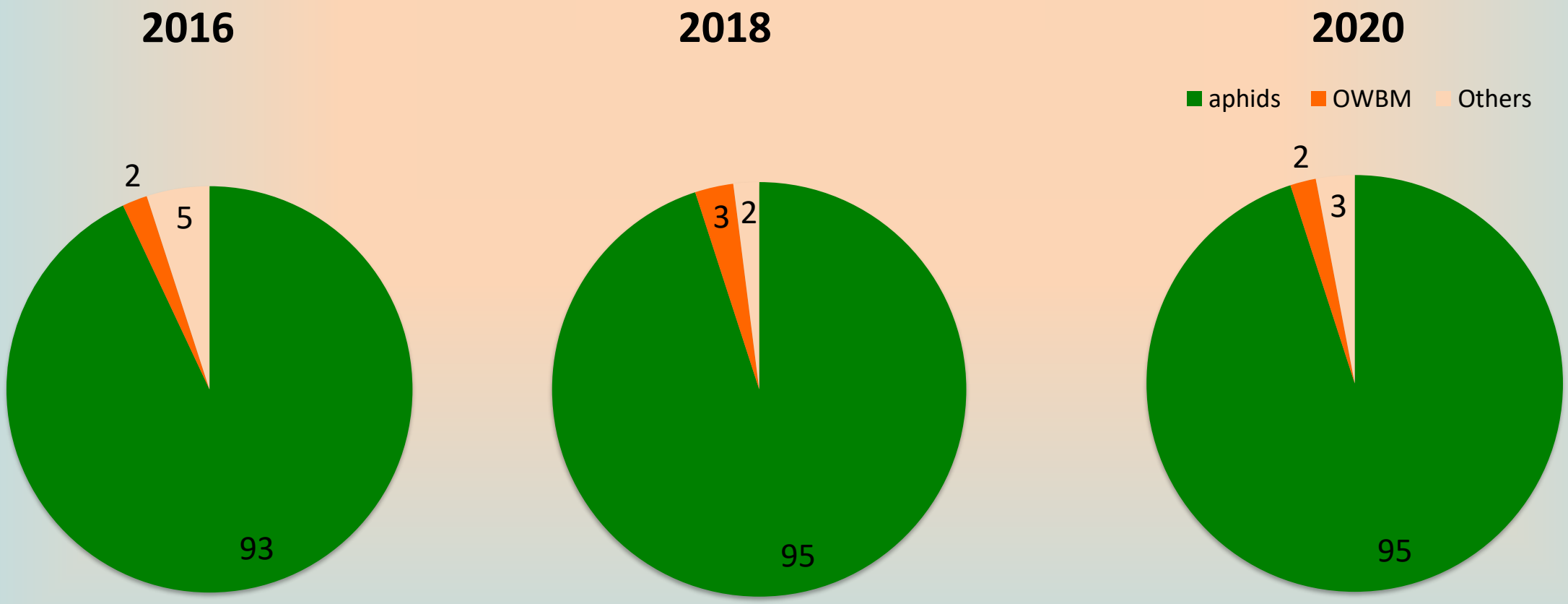
1. Achieving prevention and suppression of harmful organisms
2. Monitoring of harmful organisms
3. Decisions made based on monitoring and thresholds
4. Non-chemical methods
5. Pesticide Selection
6. Reduced Use
7. Anti-resistance strategies
8. Evaluation

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

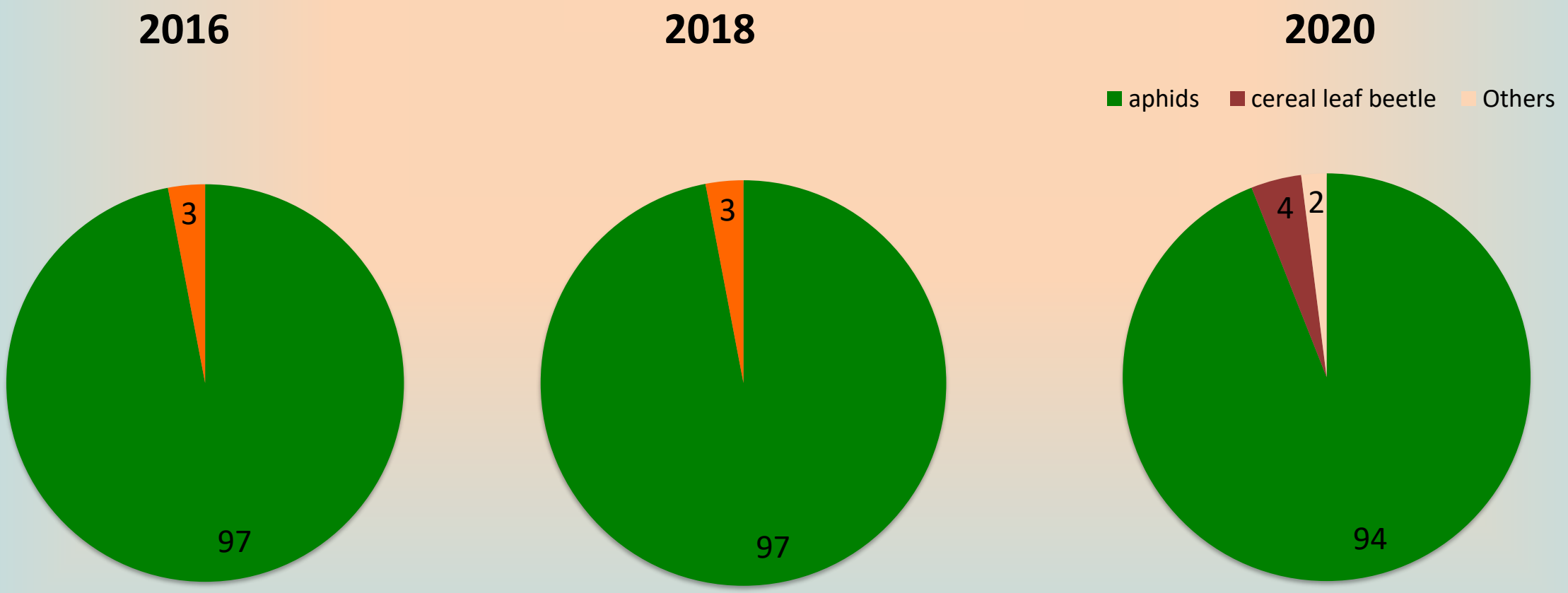
- What are the harmful organisms?
  - BYDV infection is caused by several strains (some would say ‘species’) of a luteovirus that are all transmitted by…
  - Aphids, and ONLY aphids
  - Most common strains in UK include PAV, MAV and RPV
  - The latter strain has been classed as a polerovirus within the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

Target pests for insecticides in wheat in the UK



Source: Pesticide Usage Surveys in Arable Crops: Garthwaite *et al*., 2018, 2019; Ridley *et al*., 2021

Target pests for insecticides in winter barley in the UK



Source: Pesticide Usage Surveys in Arable Crops: Garthwaite *et al*., 2018, 2019; Ridley *et al*., 2021

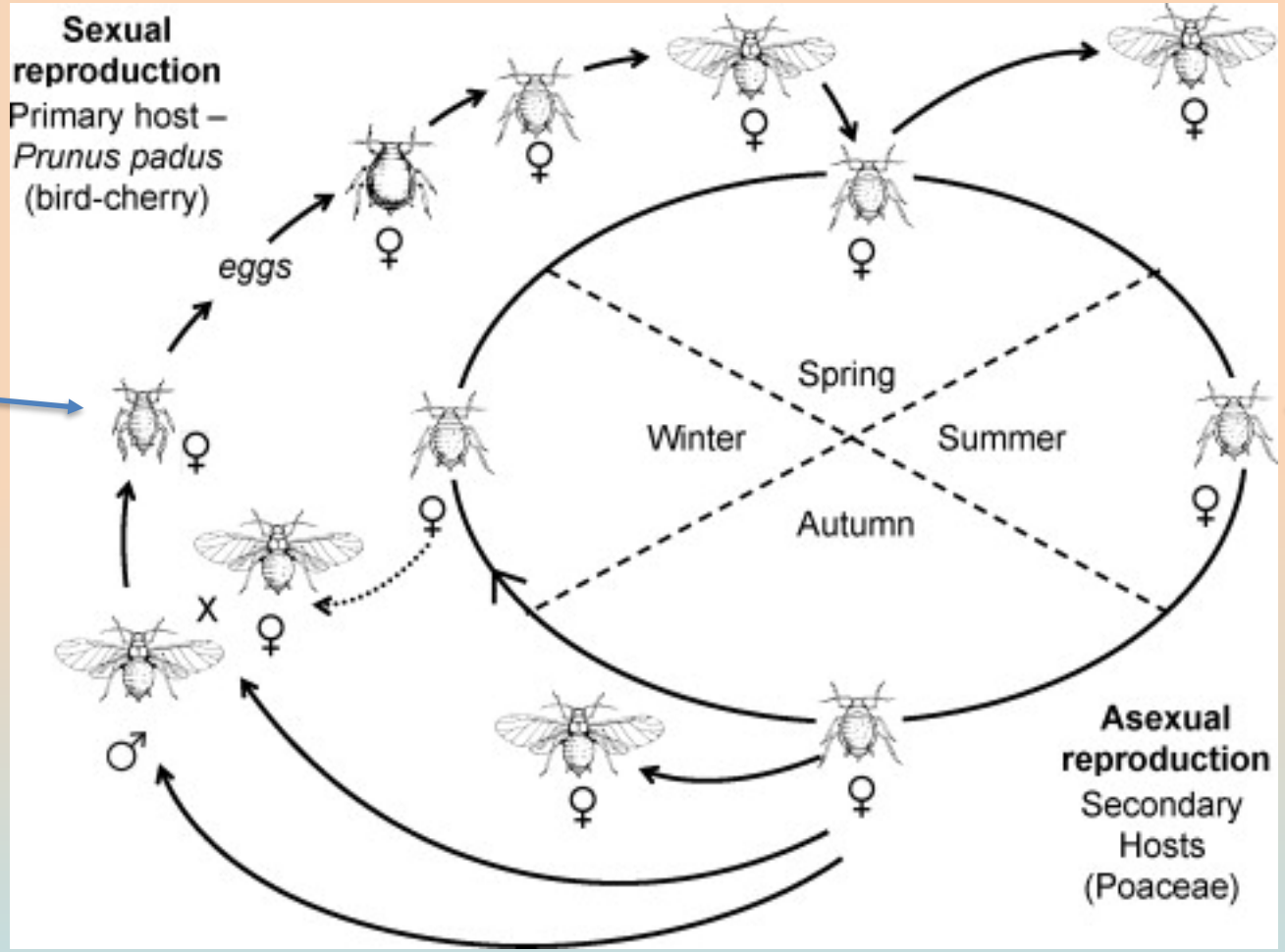
The bird cherry-oat aphid, *Rhopalosiphum padi*

- 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 (Lael *et al*., 2021)

Life cycle of *R. padi*

These aphids lose their BYDV when overwintering as eggs on the primary host



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

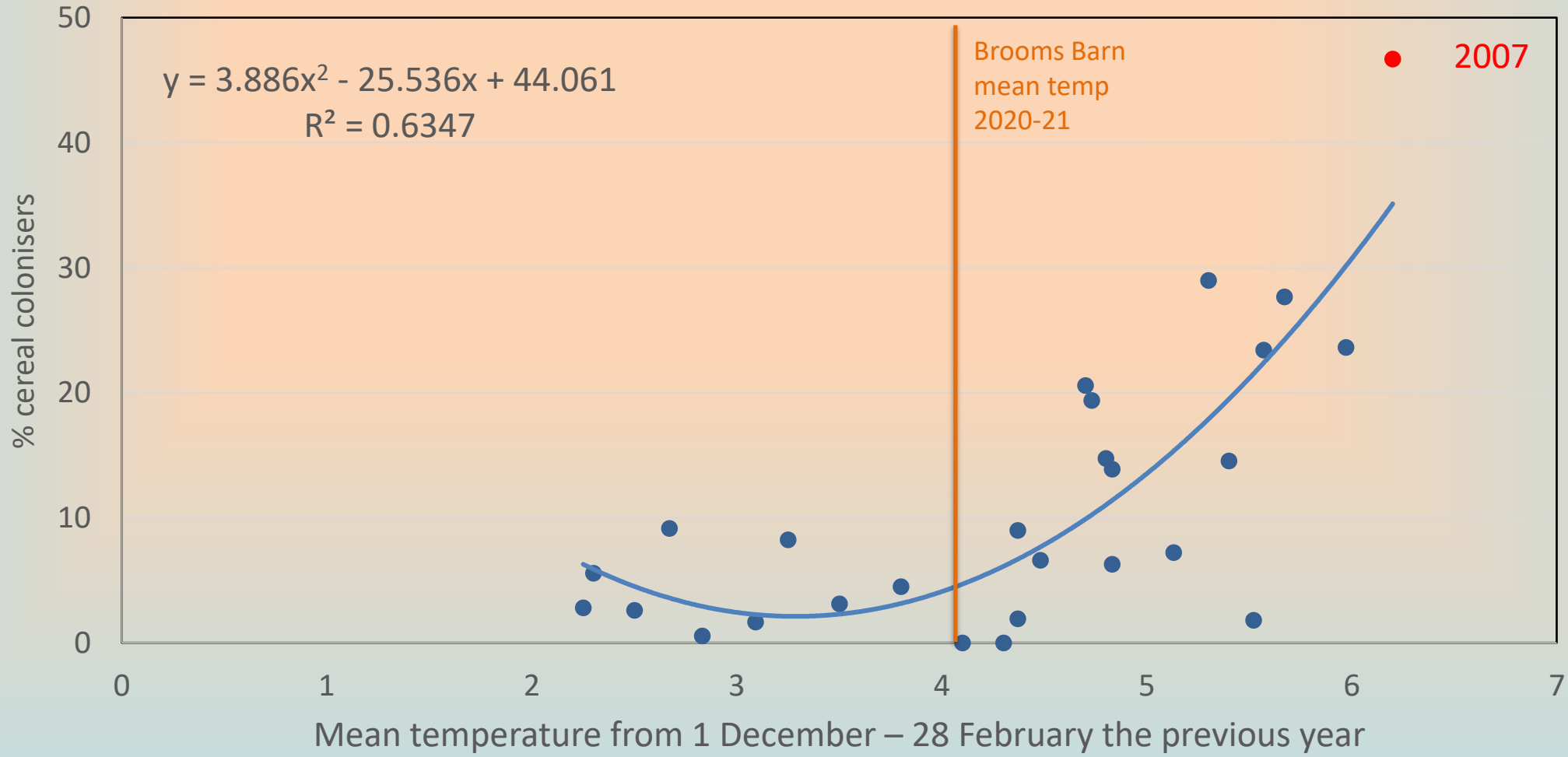
How to tell if a bird cherry aphid is a cereal coloniser

VIRGINOPARA

GYNOPARA

Source: Rothamsted Insect Survey: Lowles squash test

The effect of mean temperatures from December to February on production of cereal colonisers in the bird cherry aphid, *Rhopalosiphum padi,* in the Rothamsted suction trap, operated from 1986-2012



Source: Harrington *et al.,* 2012; Aspects of Applied Biology 117, 157-164

The grain aphid, *Sitobion avenae*

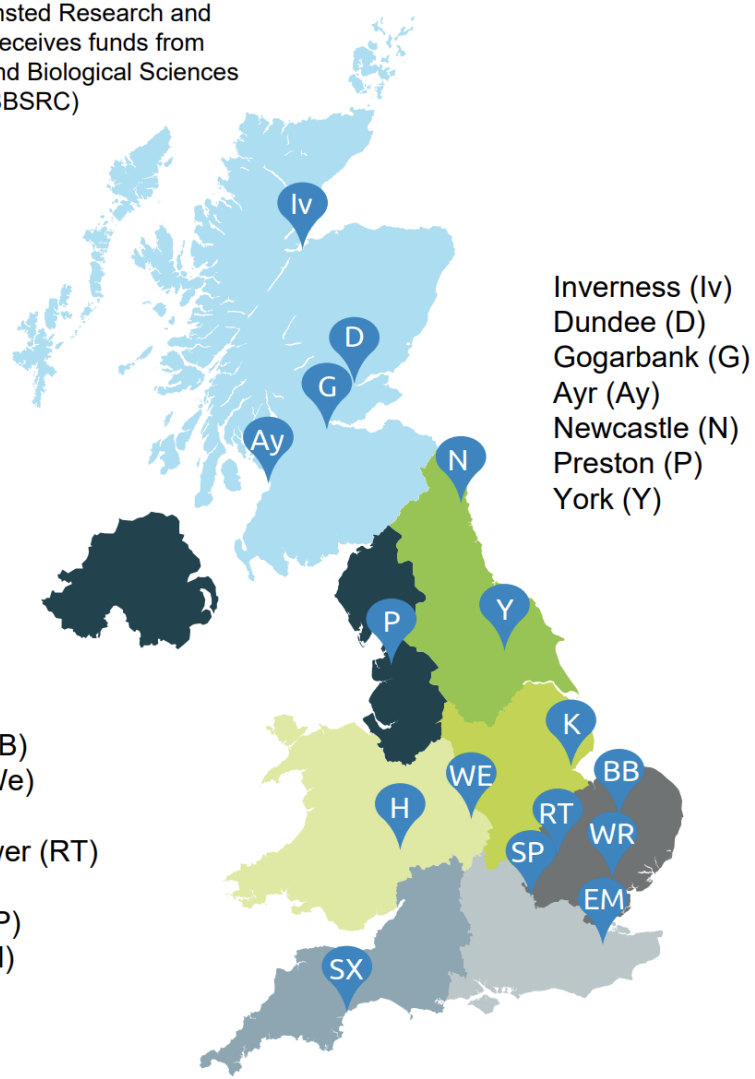
- Important pest on wheat, barley and oats
- Can reduce grain yield
- Transmits BYDV - MAV and PAV strains
- Previous good control with Deter and pyrethroids
- Control failures from pyrethroids reported in summer 2011 and springs of 2012 and 2016
- Can have a sexual cycle on Graminae, but survives overwinter mostly as asexual clones in the UK

SUD 2. Monitoring of harmful organisms

- Aphids must migrate into cereal fields each autumn
- So their migrations can be monitored
  - By suction traps – requires an entomologist
  - By sticky traps - requires an entomologist
  - By water traps - requires an entomologist
  - By direct observation in crops – needs good eyesight (and an entomologist)

The suction-trap network

Operated by Rothamsted Research and SASA, the network receives funds from the Biotechnology and Biological Sciences Research Council (BBSRC)



Inverness (Iv)
Dundee (D)
Gogarbank (G)
Ayr (Ay)
Newcastle (N)
Preston (P)
York (Y)

Kirton (K)
Broom's Barn (BB)
Wellesbourne (We)
Hereford (H)
Rothamsted Tower (RT)
Writtle (Wr)
Silwood Park (SP)
East Malling (EM)
Starcross (SX)

http://www.rothamsted.ac.uk/insect-survey/STTrapSites.php

A whole team of entomologists

http://www.rothamsted.ac.uk/insect-survey

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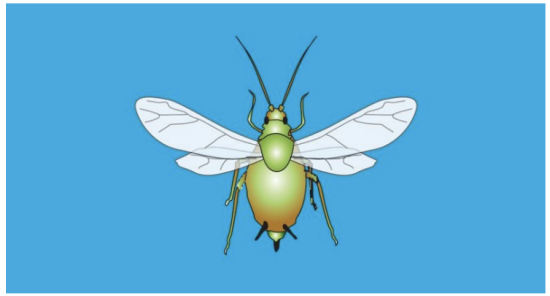
Home > Knowledge library > The UK aphid monitoring network

The UK aphid monitoring network

Find out about the national network of aphid suction traps and yellow water traps. Delivering regional information on aphid species and numbers, this monitoring resource can help guide insecticide treatment decisions.



Field pest home

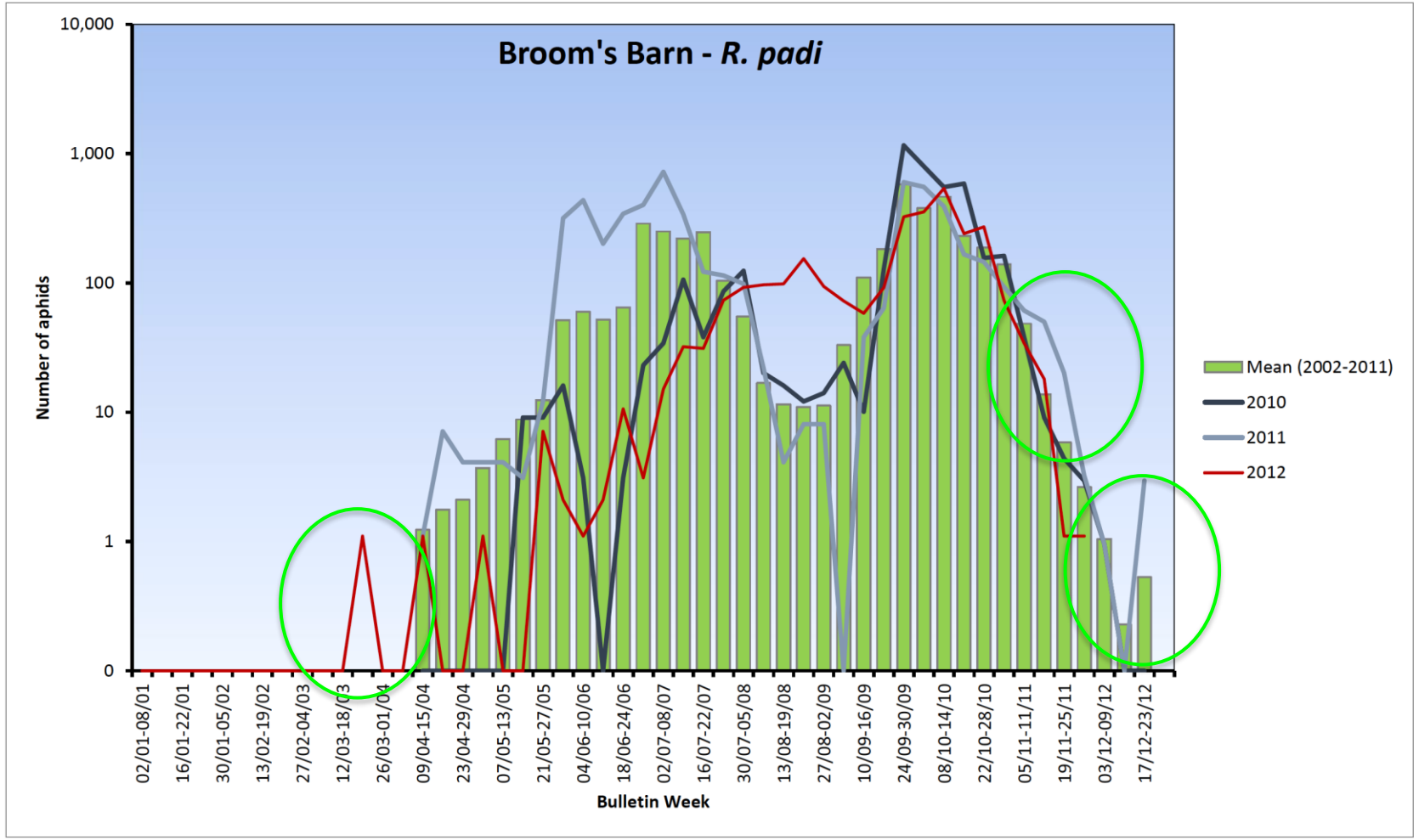
How to recognise and manage aphids in cereals and oilseed rape

Aphids and viruses in potatoes

Insecticide Resistance Action Group (includes aphid sampling protocol)

Source: https://ahdb.org.uk/knowledge-library/the-uk-aphid-monitoring-network

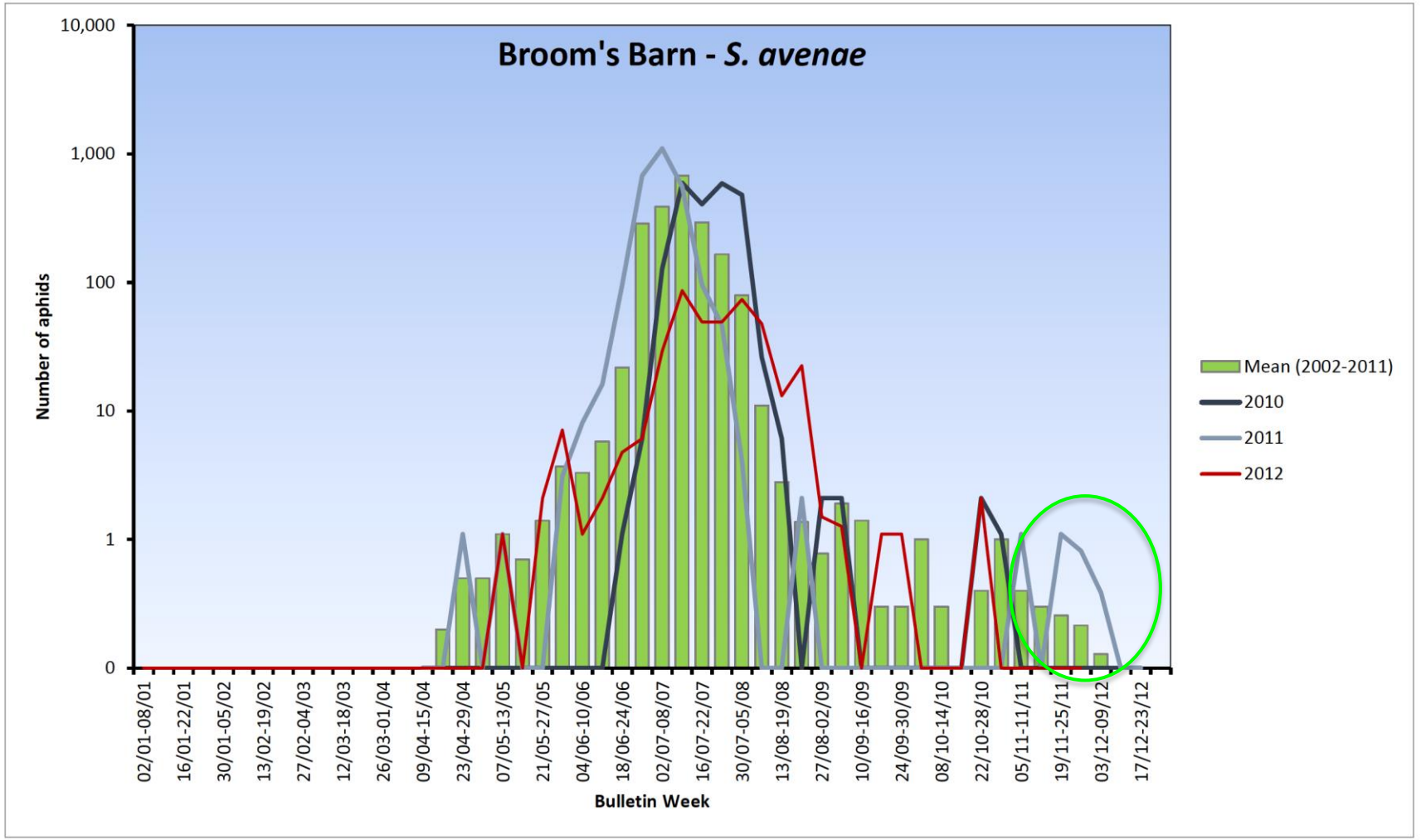
Migrations of cereal aphids in the Broom's Barn suction trap: bird cherry aphid, *R padi* in 2011-12



ROTHAMSTED RESEARCH

Source Rothamsted Insect Survey: https://insectsurvey.com/aphid-bulletin

Migrations of cereal aphids in the Broom's Barn suction trap: grain aphid, *Sitobion avenae* in 2011-12

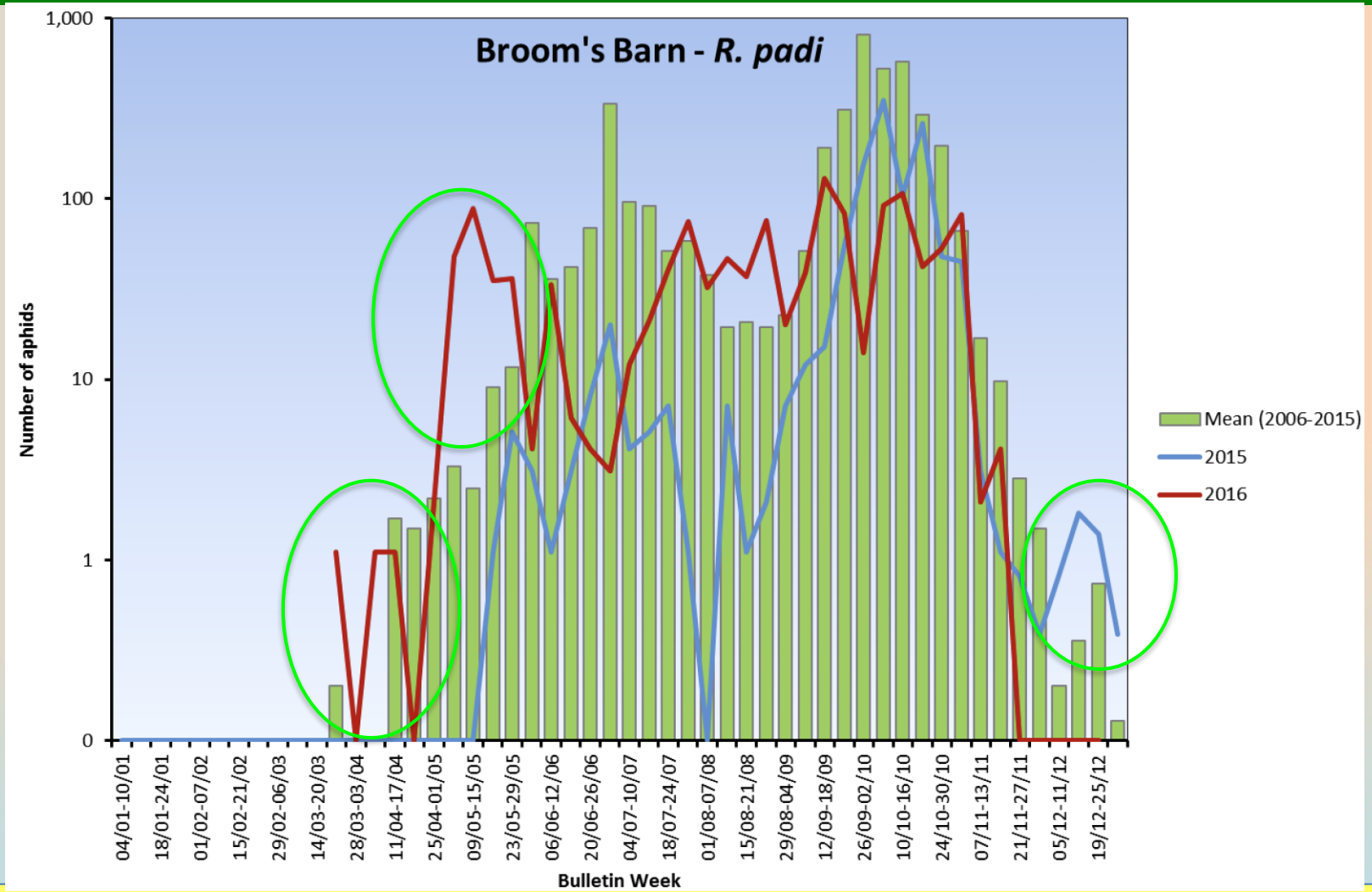


ROTHAMSTED RESEARCH

Source Rothamsted Insect Survey: https://insectsurvey.com/aphid-bulletin

BYDV in 2012 in Suffolk

Migrations of cereal aphids in the Broom's Barn suction trap: bird cherry aphid, *R padi* in 2015-16

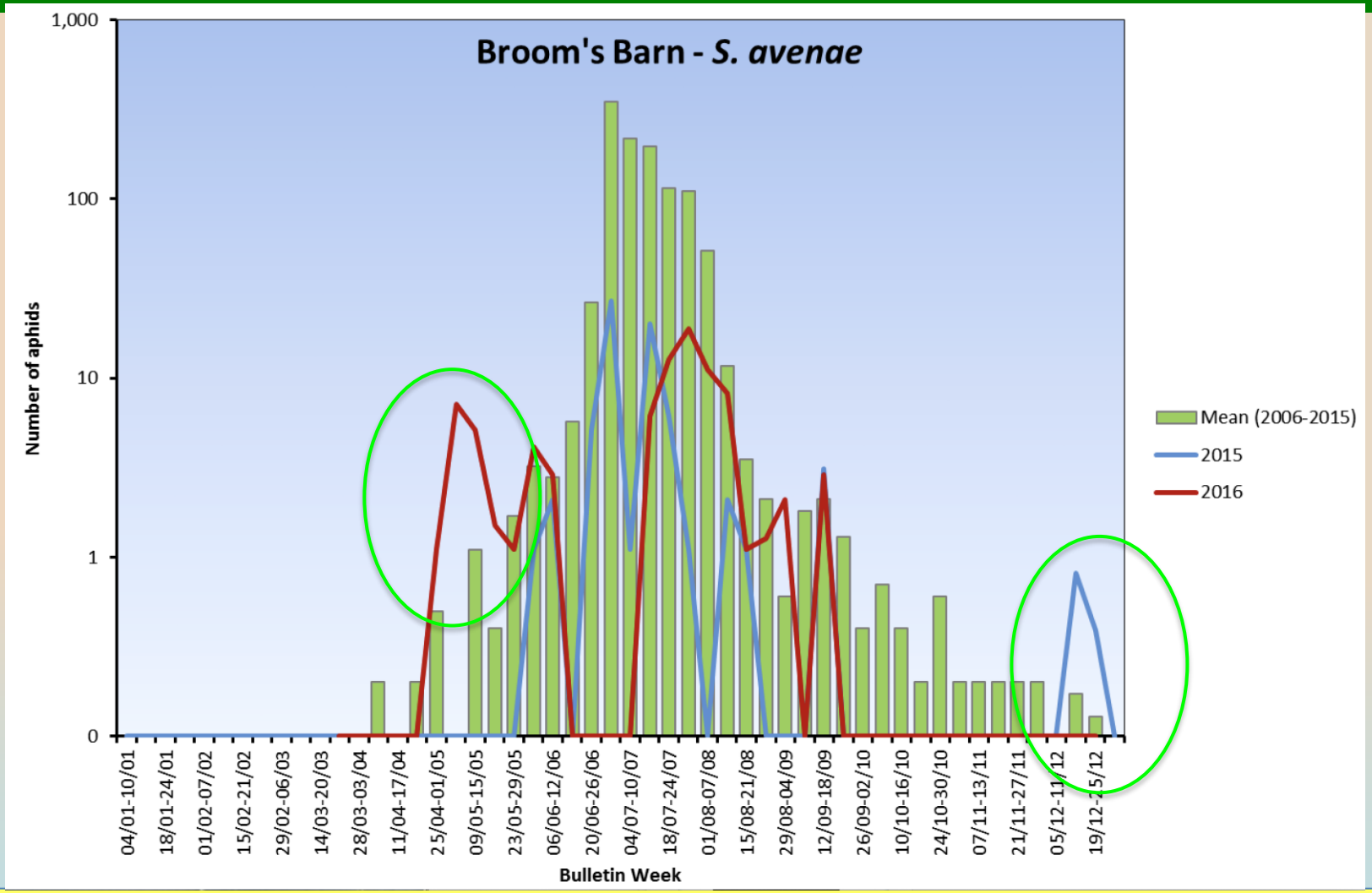


ROTHAMSTED RESEARCH

Source Rothamsted Insect Survey: https://insectsurvey.com/aphid-bulletin

DCP

Migrations of cereal aphids in the Broom's Barn suction trap: grain aphid, *S avenae* in 2015-16



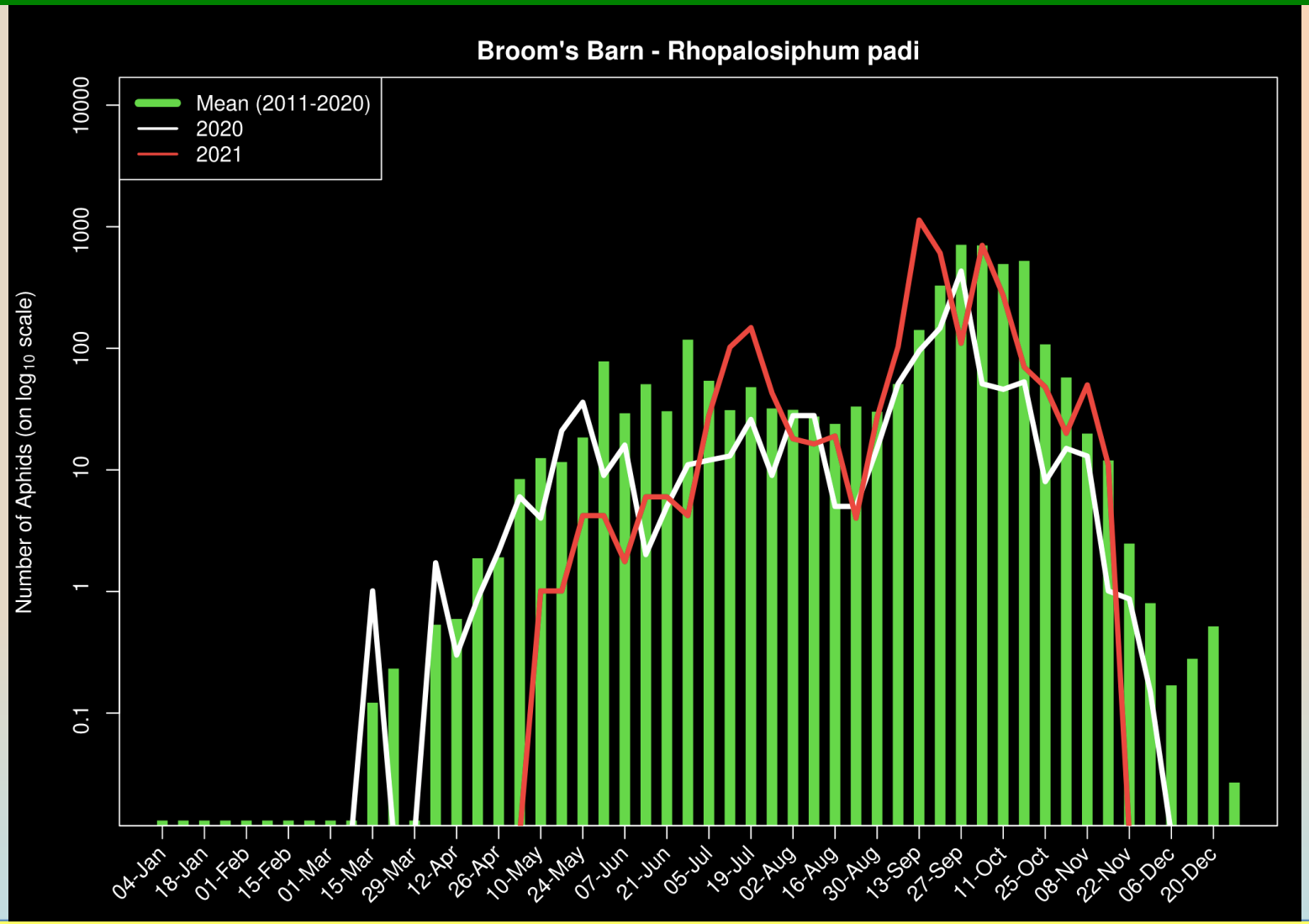
ROTHAMSTED RESEARCH

Source Rothamsted Insect Survey: https://insectsurvey.com/aphid-bulletin

BYDV in 2016 in Suffolk

Mostly caused by *Sitobion avenae* that were resistant to pyrethroids

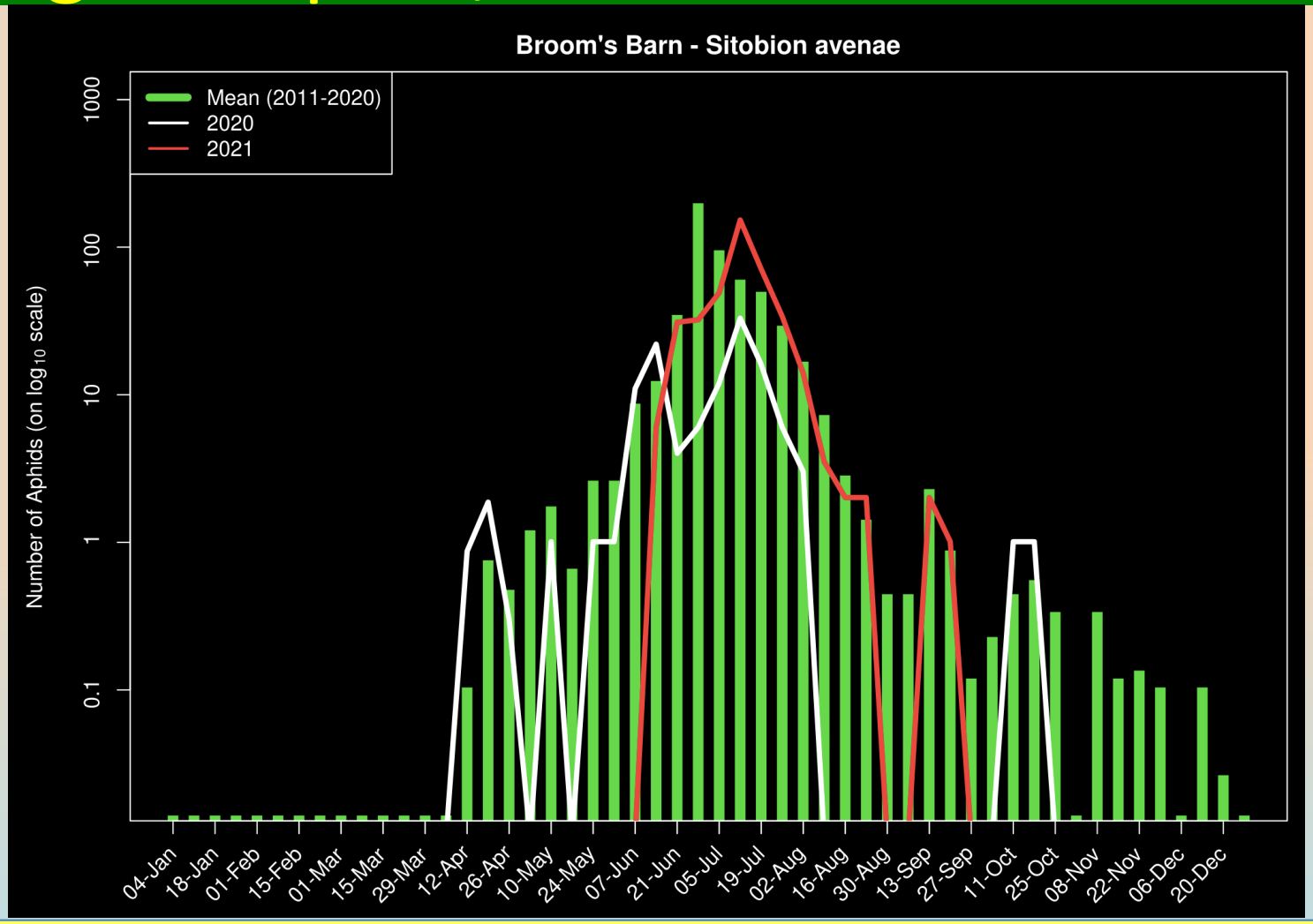
Migrations of cereal aphids in the Broom's Barn suction trap: bird cherry aphid, *R padi* in 2020-21



ROTHAMSTED RESEARCH

Source Rothamsted Insect Survey: https://insectsurvey.com/aphid-bulletin

Recent migrations of aphids in suction trap: grain aphid, *S avenae* in 2020-2021



Source Rothamsted Insect Survey: https://insectsurvey.com/aphid-bulletin

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)

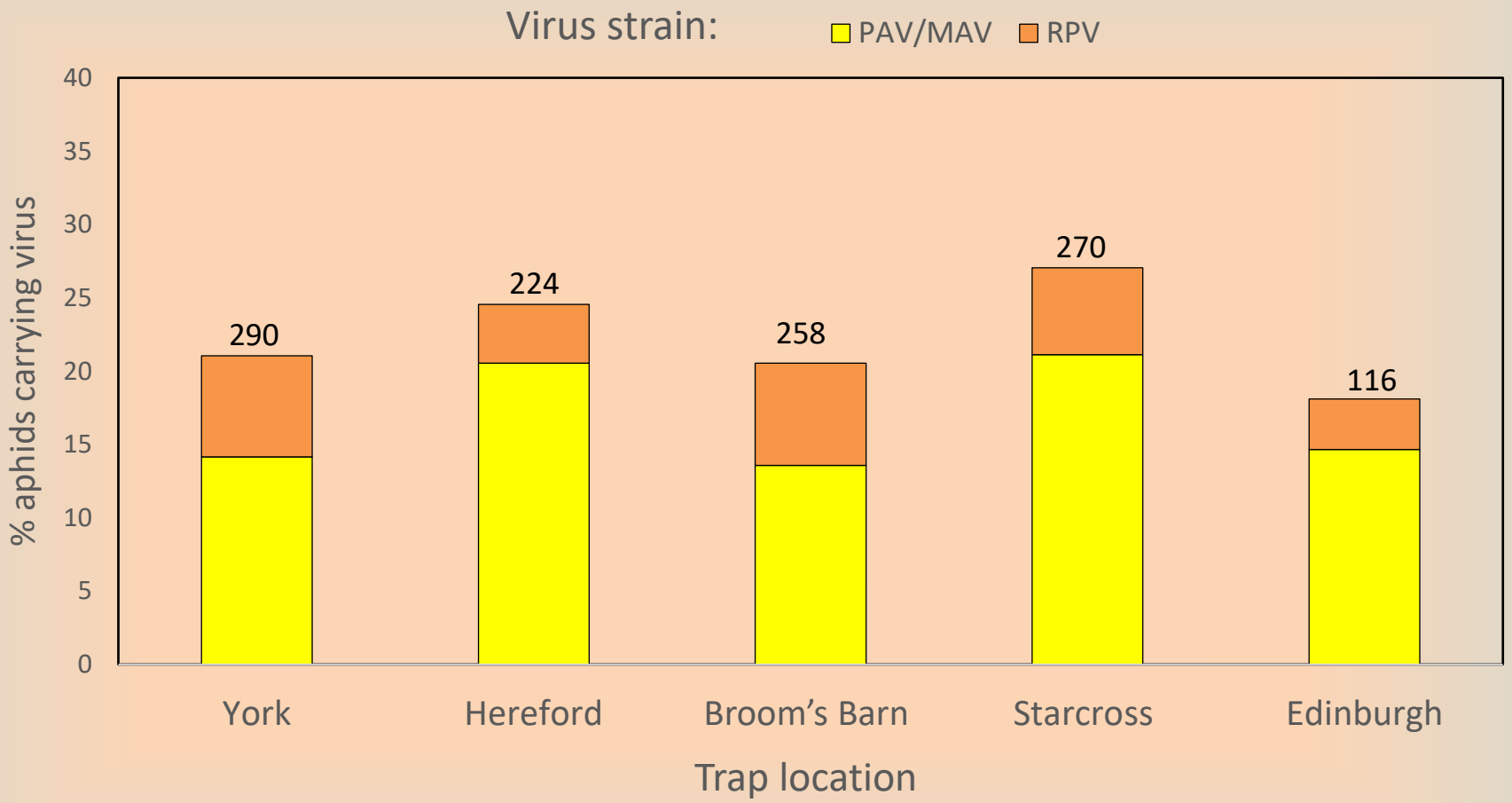
- Thresholds for aphid control with regard to suppressing BYDV are variable, and lack data to underpin their accuracy e.g. 10% of plants infested
- So, in practice, growers and agronomists assume that…
  - the only good aphid is a dead one!
  - therefore, in the absence of seed treatments, sprays are applied when the first aphid is seen, or often as part of a programme regardless of whether aphids have been seen or not

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

Percentage *R. padi* carrying BYDV (PAV and MAV) and CYDV-RPV across five English suction traps in autumn 2021



Number tested above columns

Source: Martin Williamson at Rothamsted Research
https://ahdb.org.uk/knowledge-library/the-uk-aphid-monitoring-network

ROTHAMSTED RESEARCH

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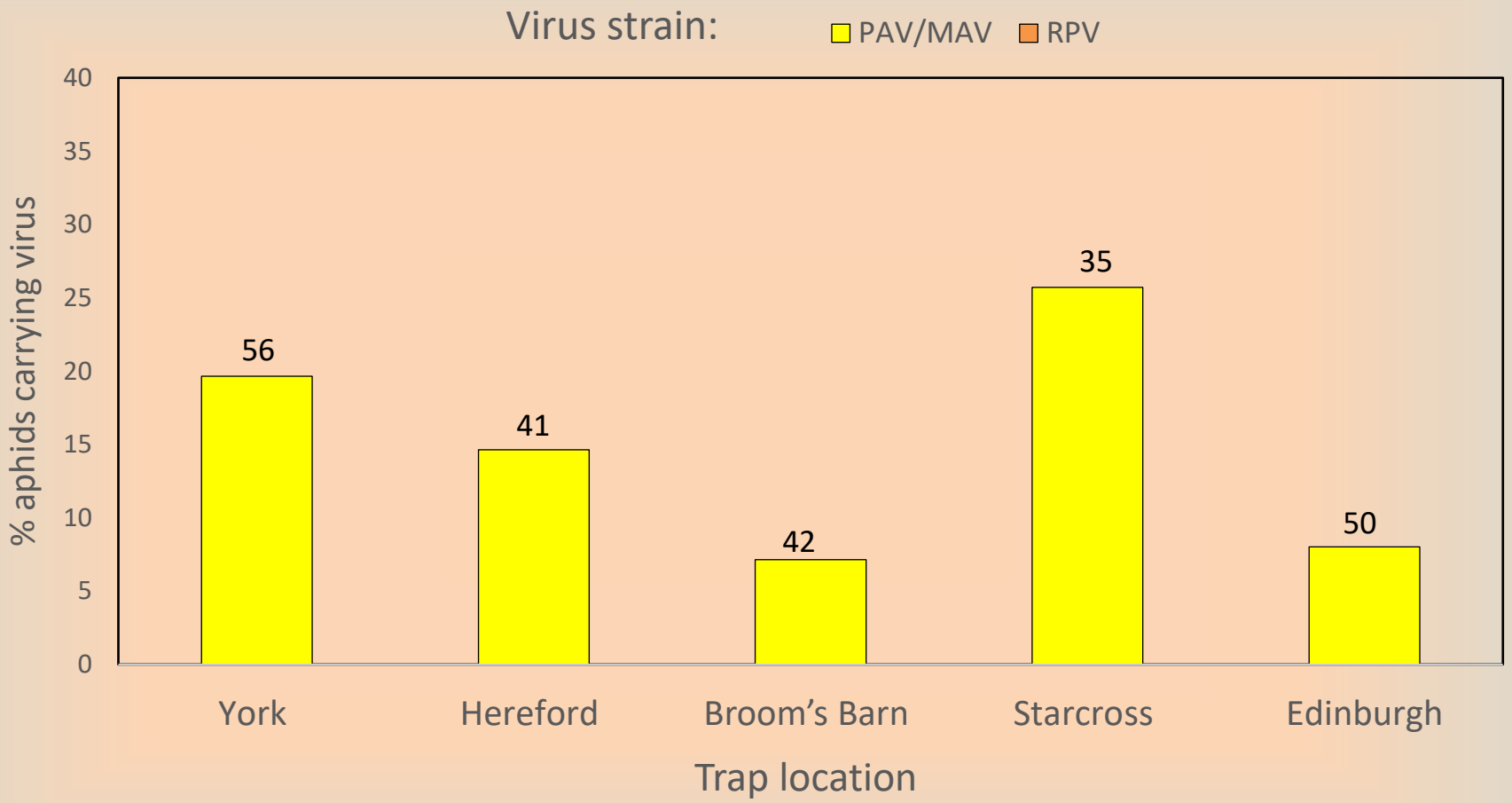
Percentage *of S avenae* carrying BYDV (PAV and MAV) across five English suction traps in autumn 2021



Number tested above columns

ROTHAMSTED RESEARCH

Source: Martin Williamson at Rothamsted Research
https://ahdb.org.uk/knowledge-library/the-uk-aphid-monitoring-network

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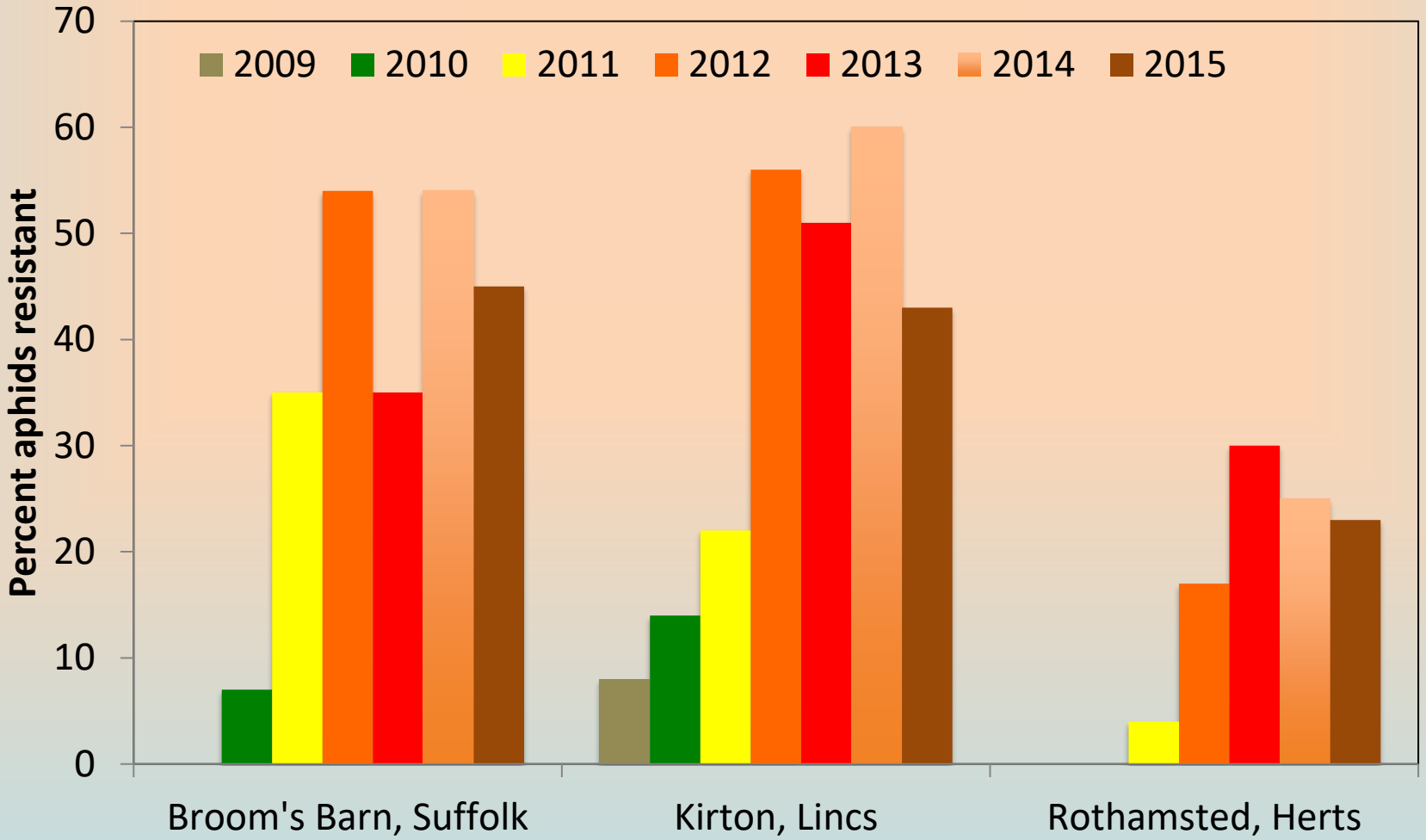
Frequency of resistant *Sitobion avenae* in Rothamsted Insect Survey suction traps: 2009 - 2015



ROTHAMSTED RESEARCH

Rothamsted not tested in 2009 and 2010; lack of funding prevented surveys from 2016-2019

Recent results from Aphid surveys done by ADAS and tested by Rothamsted Research

AHDB

Final Report

Pyrethroid Sensitivity in UK Cereal Aphids

AHDB Ref: 91120154

Reporting Period: November 2019-Feb 2021

Report Authors: Steve Foster[1], Daniel J. Leybourne[2]
[1]Rothamsted Research, Harpenden, Hertfordshire, AL5 2JQ
[2]ADAS High Mowthorpe, Duggleby, Malton. YO17 8BP

DCP

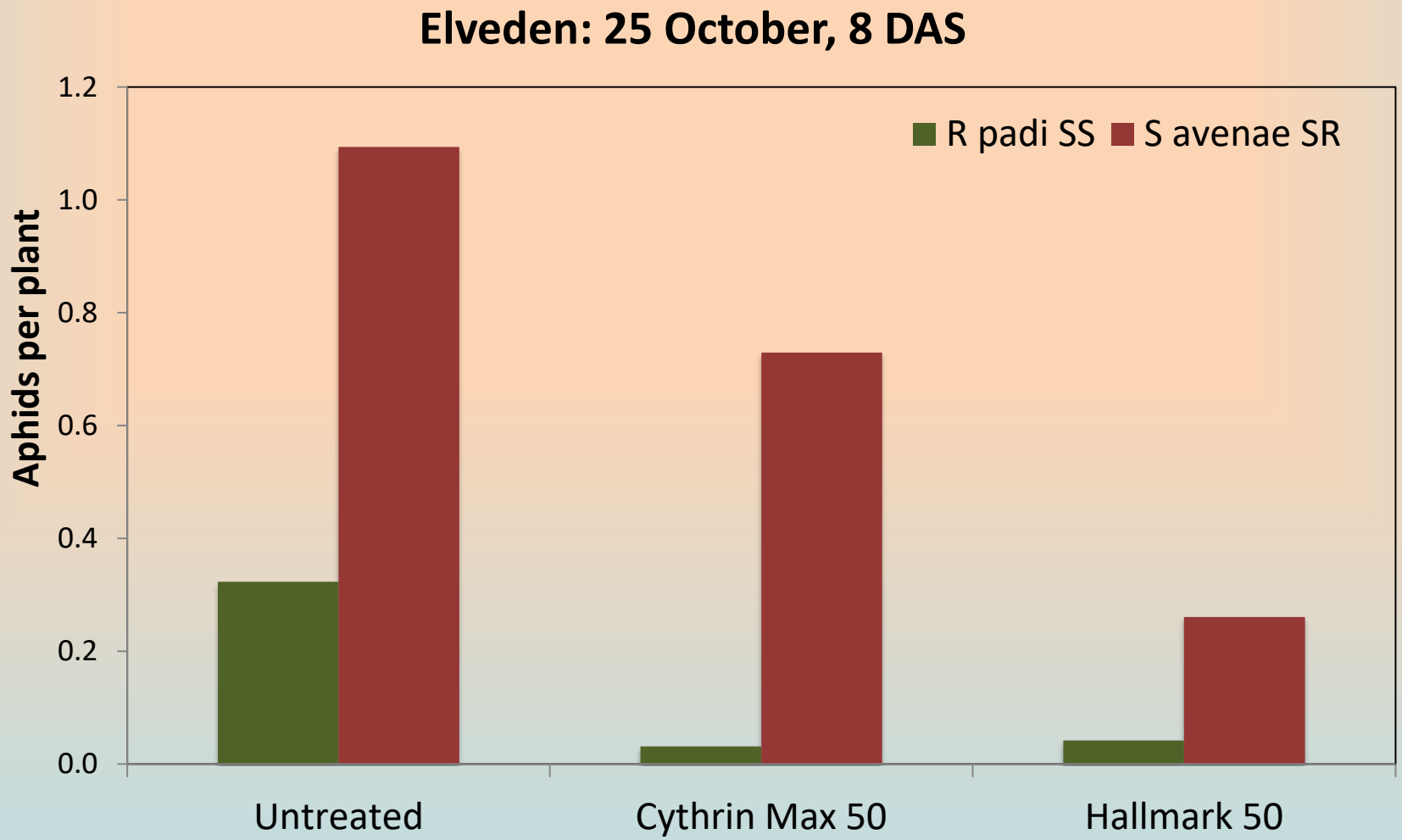
Pyrethroid sensitivity in cereal aphids in the UK since 2015

1.3. Key findings

We have gained contemporary information on the resistance status of two important virus-transmitting aphid pests of UK cereal crops. In *S. avenae*, there is no evidence of the evolution or selection of pyrethroid resistance above and beyond that already known in this species. Five samples were tested. Four samples showed statistically significant higher responses than the insecticide-susceptible baseline clone. Two of these carried moderate resistance levels (over 20-fold) associated with the kdr (knock-down resistance) mechanism that is known to be present in this species. However, and importantly, greater levels of resistance were not seen than those previously reported in 2015.

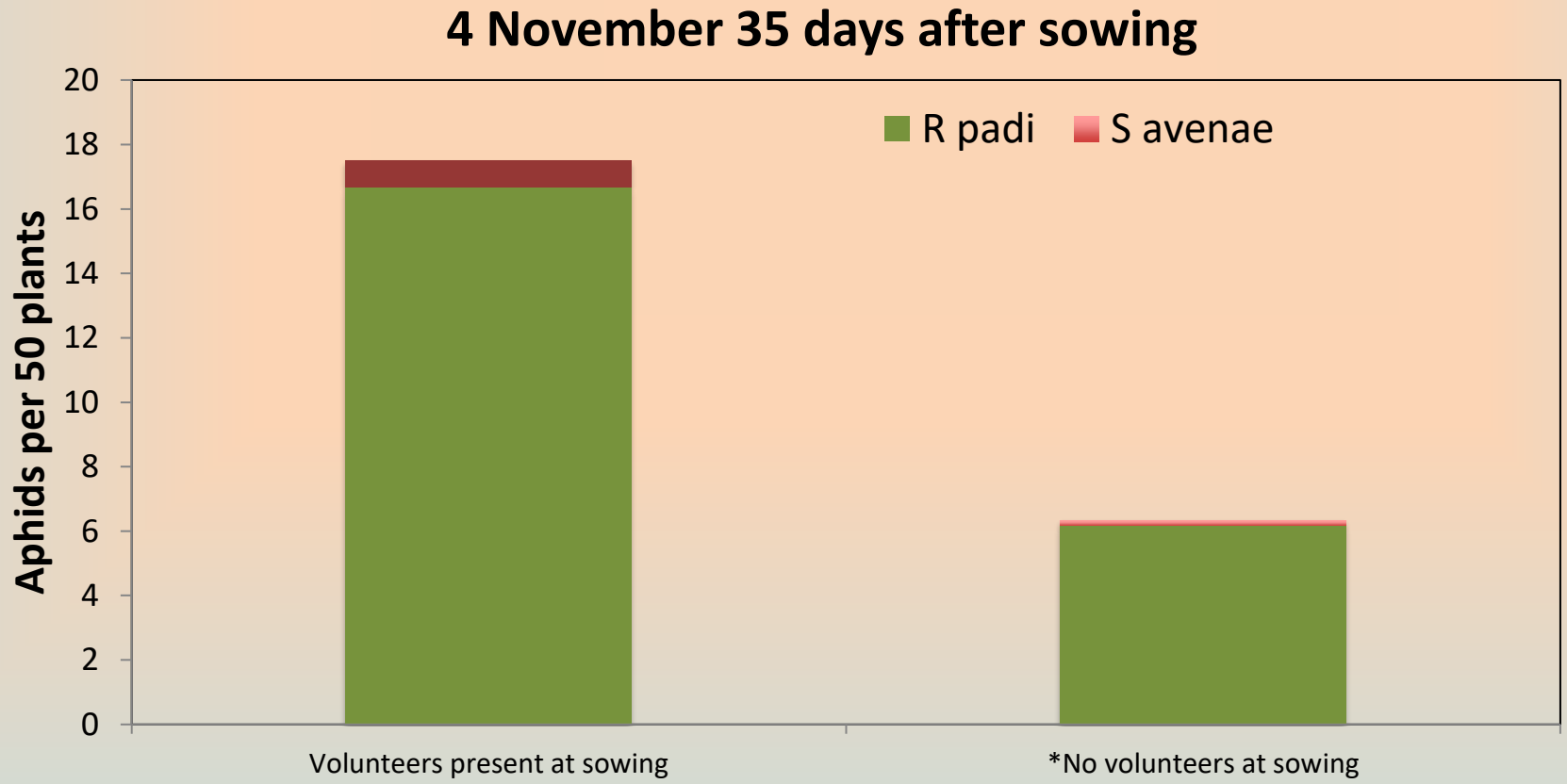
Twenty-one *R. padi* samples were tested. All of these showed bioassay responses similar to those seen in pyrethroid-susceptible aphids in this species and there was no evidence of any shift in sensitivity from that seen in recent years.

Efficacy of insecticides in winter barley against aphids in 2016



aphids inoculated on 14 October; sprays applied on 17 October

The effect of the presence of volunteer cereals on colonization by aphids of winter barley in 2021

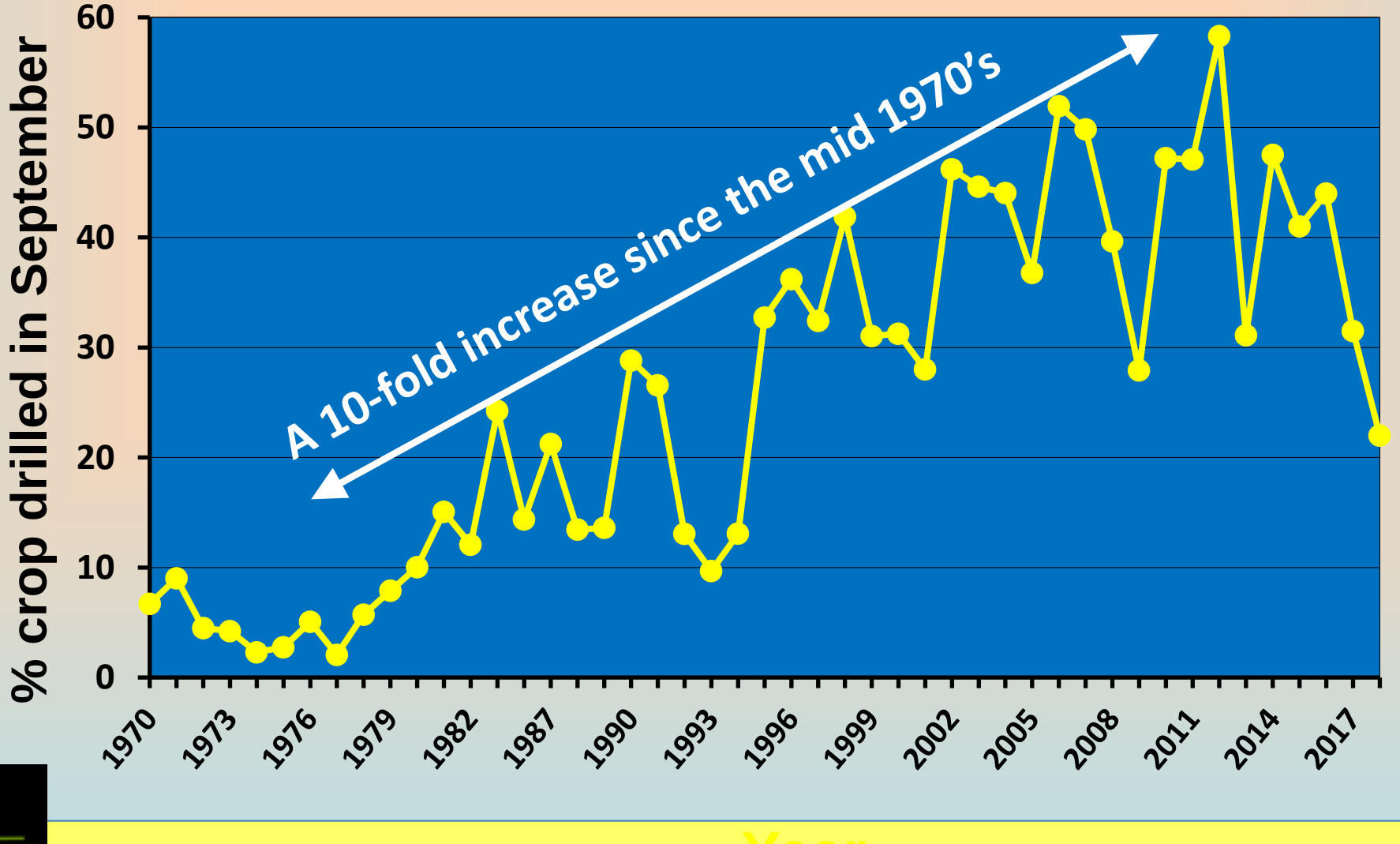


Volunteers inoculated on 16 September; crop sown on 30 September, emerged on 7 October

*Volunteers sprayed with glyphosate on 21 September, nine days before sowing, 16 days before emergence.

Source: Bayer UK 2021

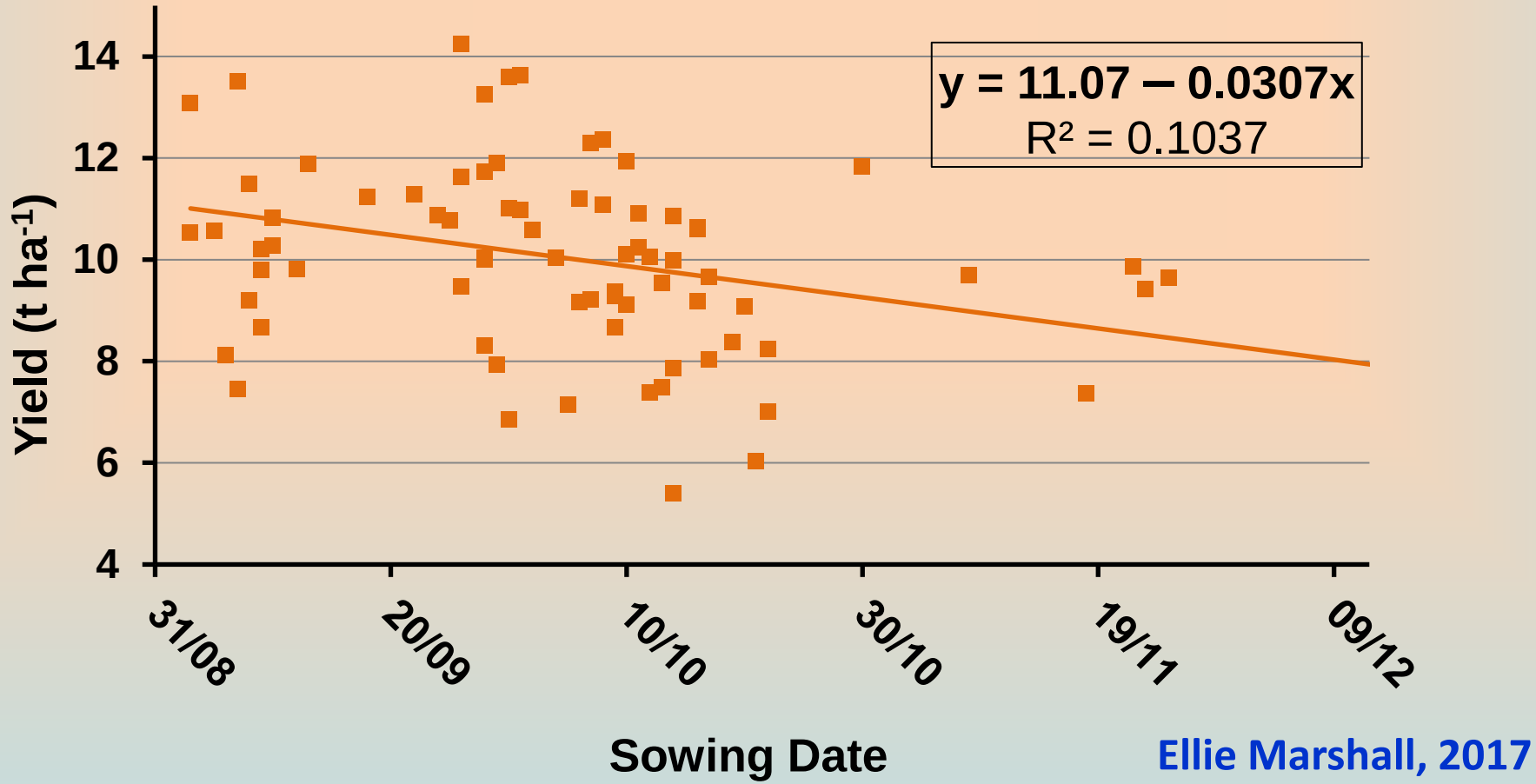
% of winter wheat crop in England sown in September (1970 – 2018 harvest years)



Source: Defra

Slide courtesy of Stephen Moss:

Impact of delayed autumn sowing on winter wheat yield (2010 -14; 84 trials)



Ellie Marshall, 2017

Delaying sowing from mid Sept to mid Oct = 0.9 t/ha (8%) loss

BYDV resistant/tolerant varieties

- Some varieties now available in specialist category

Winter barley

  - Amistar (KWS)
  - Rafaela (LG Seeds)

Winter wheat

  - Woolverine (RAGT)

BYDV resistant/tolerant varieties

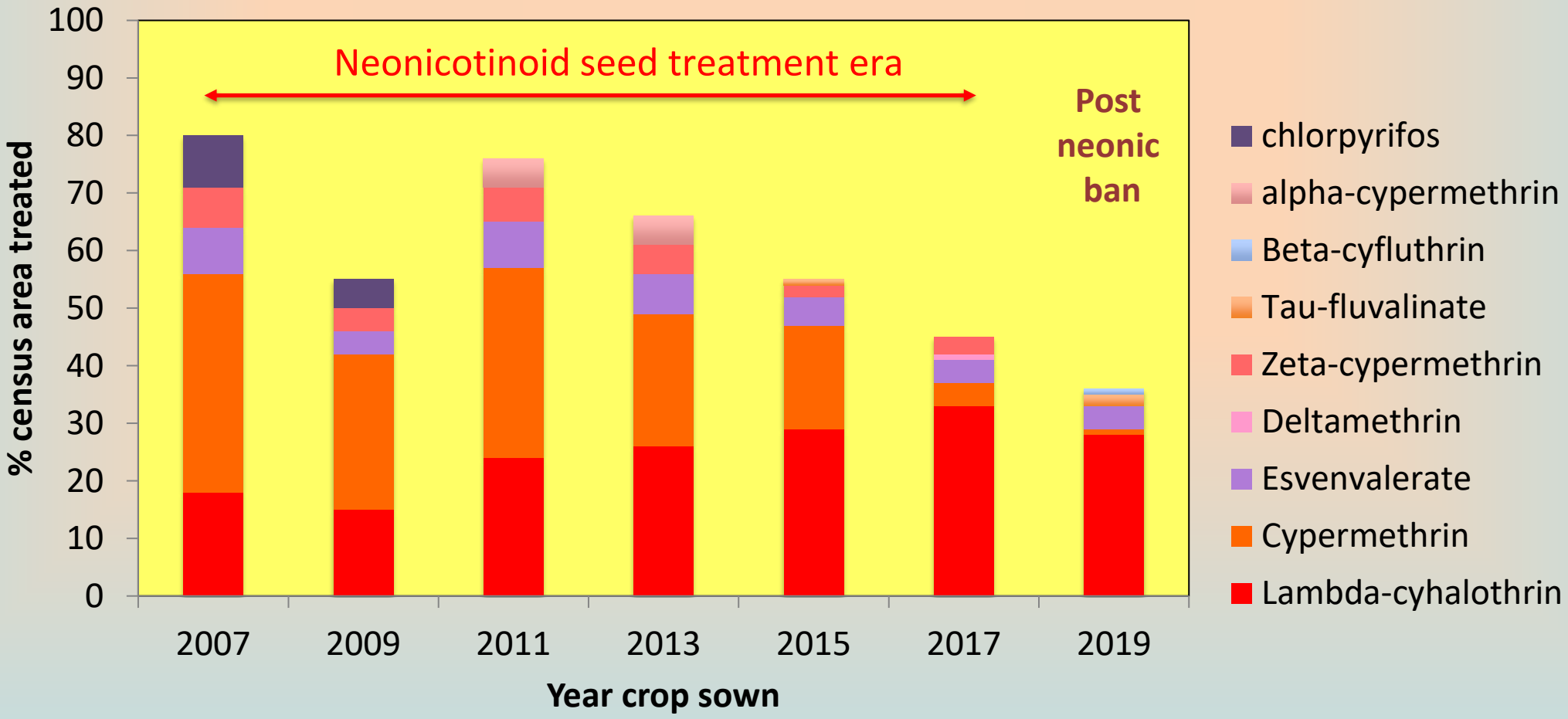
- Resistant Varieties
  - need to be high yielders
  - need not to be susceptible to other diseases that require expensive fungicide treatments
  - need to be resistant to other insect-transmitted diseases such as **wheat dwarf virus** to avoid insecticide use altogether
  - Are stacked resistance genes to multiple diseases likely to be an option in the future?

SUD 5 Pesticide Selection

- In absence of neonicotinoid seed treatments, there is a huge reliance on one class of chemical
  - Top 5 insecticides used in the last 10 years were all pyrethroids

- Nothing else is registered for use in autumn at the moment
  - This must change

Use of insecticides in wheat in the UK pre- and post-neonicotinoid ban: 2007-2019



Source: Pesticide Usage Surveys: Garthwaite *et al*., 2009, 2011, 2013, 2015, 2017, 2019; Ridley *et al*., 2021

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 more 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*

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

Good Luck