Annual Project Report 01/06/2023 to 31/6/2024

Project title	Monitoring and managing insecticide resistance in UK pests		
Project number	21510015		
Start date	1 April 2012	End date	Initiailly funded for three years, the project has received nine consecutive one-year extensions since 2015 in agreement with the (up to 16) project partners.

Project aim and objectives

This project has successfully monitored for potential reduced sensitivity and/or resistance to a range of insecticides in key UK insect crop pests to know which insecticides will work and which may not work. This has been achieved primarily through insecticide screening bioassays on live insect samples collected from the field, which have been tested in the lab at Rothamsted Research. Importantly, this approach provides an early warning of the potential evolution/selection of full-blown resistance that would probably lead to insecticide pest control failures on UK crops. It is also independent of the need to know the exact mechanism (metabolic, target site, or other) confiring resistance.

All live insect samples have been screened with relevant compounds at pre-selected, diagnostic doses (chosen through current and previous research during the course of this project). If new forms of resistance have been identified, they have been followed up to confirm the exact mechanism/s involved and then with subsequent molecular-based work we have developed relevant assays to allow fast through-put testing of multiple insect samples.

The insect sampling has been successfully achieved through the continued involvement of stakeholders, including, primarily, sub-contractors employed specifically for this purpose (Dewar Crop Protection and ADAS), and contributions from agronomy and agrochemical companies involved in the project.

Our work has focused on economically important aphid pests: such as the peach-potato aphid (*Myzus persicae*), a plant virus-transmitting species, where samples have been routinely bioassayed for their response to a range of relevant insecticides used for their control: flonicamid, neonicotinoids, spirotetramat, sulfoxaflor, pyrethroids and cyantraniliprole. We have also identified any relevant known underlying target site mutations conferring resistance using DNA-based diagnostics and have incorporated any new diagnostics as they have become available through other Rothamsted-based projects (as ‘in-kind’ contributions to the project).

We have also been screening other important UK plant virus-transmitting aphid pests, including grain aphids (*Sitobion avenae*), bird cherry-oat aphids (*Rhopalosiphum padi*), rose-grain aphids (*Metopolophium dirhodum*), willow-carrot aphids (*Cavariella aegopodii*), and black bean aphids (*Aphis fabae*) when there have been any suspected insecticide control failures reported by growers and/or agronomy advisors. This work has involved establishing insecticide-susceptible baseline bioassay data for each relevant insecticide and species to ensure appropriate screening doses are used to rapidly test for any suspected resistance in live aphid samples sent to Rothamsted Research.

Over the past decade, this project has also included live insect bioassays applied against other important UK insect pest species. These include cabbage stem flea beetles (*Psylliodes chrysocephala*), striped flea beetles (*Phyllotreta striolata*), pollen beetles (*Meligethes aeneus*), pea and bean weevils (*Sitona lineatus*), diamond back moths (*Plutella xylostella*), silver Y moths (*Autographa gamma*), asparagus beetles (*Crioceris asparagi*) and onion thrips (*Thrips tabaci*).

There are two main objectives of this long-running project. The first is to provide up-to-date information that can be used to advise agronomists and growers, as immediate end-users, on the availability of effective insecticides. The second is to provide robust scientific information to help inform Insecticide Management Strategies and support the regulatory decision-making process, via Defra/CRD. Guidance continues to be made available to advisors, growers and the scientific community through the:

Insecticide Resistance Action Group (IRAG-UK).

In addition, information has been made available during the course of the project via the AHDB website, which includes recently updated Resistance Management Guidelines (2024) tailored towards important UK crops (Cereals and Oilseeds, Potatoes and Brassicas).

Other routes of communication during the course of this project have included articles in the Farming Trade Press, presentations to growers and agronomists and papers in peer reveiwed journals and conference proceedings.

All of the reseach data gained from this project are also a valuable resource for determining long-term trends in changes in UK pest insecticide resistance frequencies and use in computer models to predict any potential future occurences/trends in insecticide resistance.

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Key messages emerging from the project

Since 1996, the *M. persicae* screening bioassays have been conducted using the methods shown in Figure 1, and have been supported by molecular-based tests for known target site resistance mechanisms to carbamates (MACE), pyrethroids (kdr and super-kdr) and neonicotinoids (Nic-R^{++}).

Figure 1. Bioassay methods used to screen live UK *Myzsus persicae* field and protected samples (clock-wise from top left: leaf dip, micro-applicationl, systemic and coated glass vial).

The long-term screening of live *M. persicae* samples for evidence of any reduced insecticide sensitivity, a potential pre-cursor to the evolution of strong resistance itself, have been achieved successfully over the course of this long-standing project. This monitoring approach has used diagnostic screening insecticide doses on live aphid samples after rearing in the lab (to ensure good insect health prior to testing).

Figure 2 summarises the 2023 *M. persicae* samples screened using bioassays and molecular diagnostics.

5906 2023	Alan Dewar	Dewar Crop Protection	11/05/2023	WOSR	Risby
5907	Alan Dewar	Dewar Crop Protection	11/05/2023	WOSR	Stetchworth, Suffolk
5908	Alan Dewar	Dewar Crop Protection	05/06/2023	Sugar Beet	Stetchworth, Suffolk
5909	Alan Dewar	Dewar Crop Protection	21/06/2023	Potatoes	Swaffham Prior, Camb
5910	Alan Dewar	Dewar Crop Protection	21/06/2023	Potatoes	Dullingham, Cambs
5911	Alan Dewar	Dewar Crop Protection	21/06/2023	Potatoes	Fowlmere, Cambs
5912	Alan Dewar	Dewar Crop Protection	02/10/2023	WOSR	Walpole, Suffolk
5913	Alan Dewar	Dewar Crop Protection	07/10/2023	WOSR	Finningham, Suffolk
5914	Alan Dewar	Dewar Crop Protection	08/10/2023	WOSR	Dullingham, Cambs
5915	Victoria Collins	ADAS	10/10/2023	WOSR	Swaffham, Norfilk
5916	David Motley	ADAS	10/10/2023	WOSR	Kirby Grind, N Yorks
5917	Victoria Collins	ADAS	09/10/2023	WOSR	Long Sutton, Lincs
5919	Laura Jones	ADAS	25/10/2023	WOSR	Moreton on Lugg,Herefordshi
5920	Laura Jones	ADAS	25/10/2023	WOSR	Stock Prior, Herefordshir
5921	May Jarvis	ADAS	03/11/2023	WOSR	Presteigne, Powys
5922	Alan Dewar	Dewar Crop Protection	20/11/2023	WOSR	Dullingham, Cambs

Figure 2. Summary of 2023 *Myzus persicae* samples screened for insecticide resistance.

Figure 3 shows how screening bioassay data (in this case, for the insecticide, Flonicamid) are plotted to allow a comparison of *M. persicae* sample responses to an established fully-susceptible insecticide baseline.

For simple interpretation, we present our bioassay data in a dose-response graph using a traffic-light system:

- Green box: fully insecticide-susceptible samples
- Amber box: reduced insecticide sensitivity
- Red box: strong insecticide resistance

These three categories allow a simple evaluation of our screening bioassays.

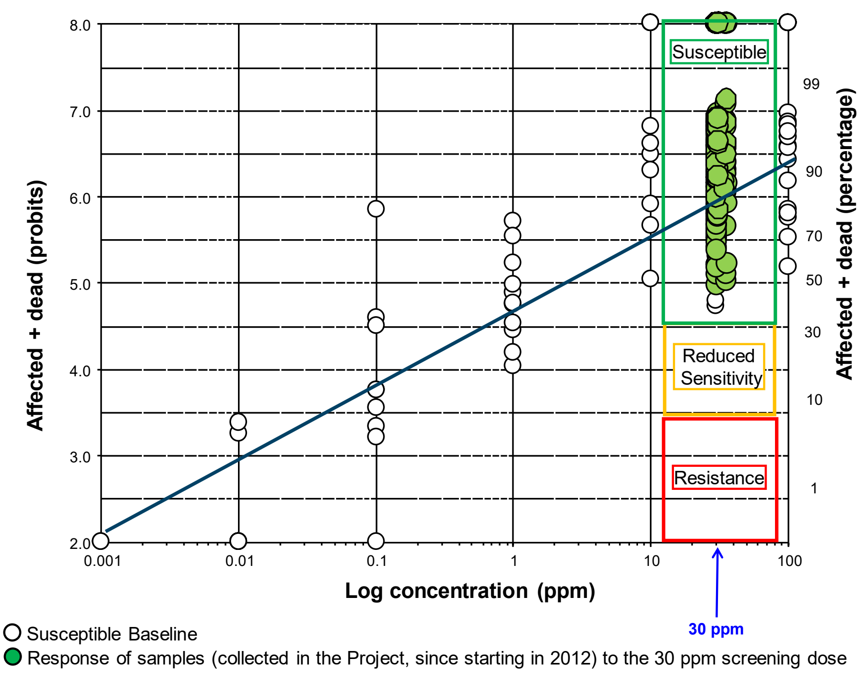

Figure 3. Response of live *Myzus persicae* field and protected samples to the screening dose of Flonicamid (on early instar nymphs) in comparison with the Flonicamid-susceptible baseline.

This approach has shown that there have been no detectable shifts in reduced sensitivity to the aphicides Cyantraniliprole, Flonicamid or Spirotetramat, available for controlling *M. persicae* in the UK.

In contrast, a significant finding during the last year has been the first time discovery of a UK *M. persicae* sample carrying strong Neonicotinoid (Nic-R$^{++)}$ resistance. This sample was collected in Suffolk from oilseed rape in autumn 2023.

This strong Nic-R^{++} phenotype was initially diagnosed in our aphid screening bioassays applying Imidacloprid and Acetamiprid. In both of these bioassays we saw healthy adult aphids capable of producing viable nymphs at our selected screening doses. This is the first time this result has been observed since *M. persicae* screening started at Rothamsted Research in 1996. Strong (Nic-R^{++}) Neonicotinoid resistance has previously been seen in mainland Europe *M. persicae* samples, but has not yet been recorded in the UK until now.

The finding was supported by follow-up molecular assays, which further confirmed that these aphids carry the recognised Neonic R81T target site mutation. Interestingly, these UK aphids also carred the *Ne* super-kdr mutation (M918L) in the homozygous (RR) form, a genotype and resistance combination never seen anywhere before. This means that neither neonicotinoids nor pyrethroids will control these aphids on UK crops.

In addition, micro-satellite testing, done at the James Hutton Institute (through an 'in-kind' collaboration), has shown that aphids in this Nic-R++ sample carry a unique genotype and therefore most likely originate from abroad, where sexual reproduction and the mixing of genes, occurs.

We need to establish, through further funding, the frequency and potential geographical spread of these aphids in the UK as this new clone could have a significant impact on aphid and therefore virus control in UK crops, including oilseed rape, sugar beet and potatoes.

Figure 4 shows a summary of the molecular testing of all the *M. persicae* samples collected in 2023. Continued monitoring for UK Nic-R++ aphids (via bioassays on live samples and molecular assays for the R81T mutation in both live samples and suction trap samples) is now crucial.

2023 Mp	S431F MACE	L1014F kdr	M918T skdr	M918L UK	M918L SPN	R81T NicR	
5906	SS	SR	SS	SS		SS	
5907	SS	SR	SS	SS		SS	
5909	SR	SR	SS	SS		F	New Target Site Codon? Est-R3
5912	SR	SS	F	RR		SR	New Super-RR Genotype Est-R1
5913	SS	SR	SS	SS		SS	Est-R3
5914	SS	SS	SS	SS		SS	
5915	SR	SS	SS	SR		SS	
5916	SS	SS	F	RR		SS	New Super-RR Genotype Est-R2
5917	SR	SS	SS	SR		SS	
5919	SS	SS (SR)	SS	SR (SS)		SS	
5920	SS (SR)	SR (SS)	SS	SS (SR)		SS	
5921	SR	SS	SS	SR		SS	
5922	SS	SS	SS	SS		SS	Est-R3

Figure 4. Resistance genotypes in UK 2023 *Myzus persicae* samples (using SNP molecular analysis).

In 2023 there have also been several reports from glasshouses on the English south coast of control problems against *M. persicae* on sweet peppers using the insecticide Flonicamid (Jude Bennison, *pers. comm.*). Resistance to this alternative (non-neonicotinoid) insecicide has also recently been reported in this aphid species across the English Channel in Holland. These UK reports need urgent follow-up monitoring through sampling and bioassays due to the implications they have in the future control of this pest. If Flonicamid-resistant aphids are found to be present in the UK and spread, this could well have a significant impact on sugar beet yields, as Flonicamid could well be the sole remaining alternative insecticide control method for *M. persicae* on this crop in light of our findings of resistance to neonicotinoids and pyrethroids.

Our work in this project suggests that at least some of the *M. persicae* collected from protected crops (glasshouses and polytunnels) originate from more genetically-diverse, sexually-reproducing, foreign populations, that have probably entered the UK on imported plant material. Samples collected from these latter sources have tended to carry rarer combinations of resistance genotypes and could potentially carry new resistance mechanisms to the UK that have evolved abroad, as we suspect was the case for MACE resistance (specifically to the di-methyl carbamate, Pirimicarb) in the 1990s. Of course, an alternative route of entry to the UK is via winged adult aphids/alatae flying in (as is most likely for our recent discovery of Neonic R^{++} aphids in Suffolk).

The mutation confering kdr (L1014F), primarily seen in the heterozygous form (conferring moderate resistance to pyrethroids), has been found in higher frequencies in the past few years (46% in our samples in 2023).

We have continued to monitor for MACE resistance (to Pirimicarb, in the absence of selection pressure after this insecticide was withdrawn from widespread use in the UK) to see if this resistance mechanism declines in frequency due to the general lack of use and as a potential measure of insecticide resistance carrying a fitness cost in the absence of selection pressure. MACE frequencies had been falling in past few years but were found at a higher frequency in our *M. persicae* samples collected in 2023 (at 46%). Interestingly, some of the *M. persicae* field samples that we have tested in our bioassays over recent years have contained adults that were fully susceptible to Lambda-cyhalothrin but, in contrast, were resistant to Esfenvalerate (both Pyrethroid insecticides). This finding of a phenotypic difference in response is probably a result of a new, as yet unidentified resistance mechanism to the latter compound in this pest.

During the course of this project we have successfully accumulated a large and unique database of relevant bioassay methods and insecticides for testing a range of important UK aphid pests. As a result, we have been able to establish insecticide-susceptible baselines and diagnostic screening doses which will be available for future testing in anticipation of control problems associated with the evolution of resistance. These data allow these pests, to be quickly screened for potential insecticide resistance. As a result, we can verify whether this is the presence of true resistance or just a result of poor insecticide application/contact (a scenario which can occur).

In the thousands of grain aphids (*S. avenae*), a pest that transmits several important cereal viruses, that have been tested during the course of this project (through ‘in-kind’ support to this project from AHDB), no kdr-RR (homozygote) genotypes have ever been found. This may relate to a fitness cost associated with this genotype (as postulated to occur in other insect pests), or the inability of kdr-SR heterozygotes (mainly thought to be a super-clone: Sav3 in the UK) to produce both males and females that would be able to mate and produce kdr-RRs which potentially carry greater pyrethroid resistance above kdr-SRs.

Up until recently, we have shown that moderate pyrethroid resistance exists in *S. avenae* in UK cereals but that this should not compromise control if these insecticide sprays are applied at the full recommended 100% field rate (5 g ai/ha) and there is good contact with the pest. However, in spring 2024 Alan Dewar (of Dewar Crop Protection) made Rothamsted Research aware that he had found *S. avenae* in cereal crops grown in eastern England in unprecedented high numbers for this season. The population was located in Norfolk and the crop they were found in had received three pyrethroid spray applications. This observation suggested a control failure with pyrethroids and the possibility that this aphid pest had evolved pyrethroid resistance ‘above and beyond’ the moderate heterozygous (kdr-SR) target site level that we have found previously in samples collected and tested from cereal crops. In an aphid sample collected from this wheat field in April 2024 we confirmed that it contained aphids carrying the kdr-SR genotype. This was followed up by testing of aphids reared from this sample in Lambda-cyhalothrin (coated glass vial) bioassays. These showed a higher Resistance Response (x 62), above that seen in our bioassays in the past for standard kdr-SR genotypes, although the LC_{50} 95% confidence limits for this Norfolk sample overlapped with those for our kdr-SR standard clone (Figure 5).

Standard Baseline Clone/ UK Sample	N[a]	LC_{50}[b]	95% CL[c]	Slope	Response Ratio[d]
Sa-kdr-SS	230	1.14	0.66-1.87$_a$	1.6	1
Sa-kdr-SR	201	39.4	17.7-75.7$_c$	2.7	35
Sa1 (2019)	215	3.13	0.89-9.85$_a$	1.8	2.8
Sa3 (2020)	184	5.17	3.35-8.01$_b$	1.3	4.5
Sa5 (2020)	209	8.30	3.62-20.6$_{bc}$	1.4	7.3
Sa4 (2020)	192	25.0	7.07-178$_{cd}$	1.0	22
Sa2 (2020)	226	33.3	11.2-73.5$_{cd}$	2.1	29
Sa3 (2024)	140	70.6	43.5-134^{cd}	1.1	62

Figure 5. LC_{50} responses to lambda-cyhalothrin (ng ai/cm^2) after 5h exposure in coated glass vial assays of UK samples of *Sitobion avenae* vs standard Sa kdr-SS and kdr-SR reference clones.

There continues to be no evidence of pyrethroid resistance in two other important cereal aphid pests, the bird cherry-oat aphid (*Rhopalosiphum padi*) and the rose-grain aphid (*Metopolophium dirhodum*), although reduced sensitivity (with a Response Ratio of x5) have been recorded in the past. Having said this, live aphid samples have not been tested since 2020 and contemporary testing of these two species is therefore needed.

Of the 14 cabbage stem flea beetle (CSFB: *Psylliodees chrysocephala*) samples collected at oilseed rape harvest in England and tested in 2023, 13 samples contained pyrethoid-resistant adults (ranging in frequency from 7% to 95%). These are similar findings to CSFB samples tested as part of this project in the past several years. The one Scottish CSFB sample tested in 2023 contained 27% resistant beetles. This was the first time that pyrethroid resistance has been seen in CSFBs in Scotland, as all previous samples from this country have tested in our bioassays as fully pyrethroid-susceptible in the past.

During the course of this project, pyrethroid resistance has also been found in a wide range of other important UK insect pests, including willow-carrot aphids (*Cavariella aegopodii*) (Figure 6), striped flea beetles (*Phyllotreta striolata*), pollen beetles (*Meligethes aeneus*), pea and bean weevils (*Sitona lineatus*), diamond back moths (*Plutella xylostella*), silver Y moths (*Autographa gamma*), asparagus beetles (*Crioceris asparagi*) and onion thrips (*Thrips tabaci*). In addition, we have also found that UK onion thrips carry resistance to the insecticide spinosad. This appears to be regional with resistance being seen towards the western side of England.

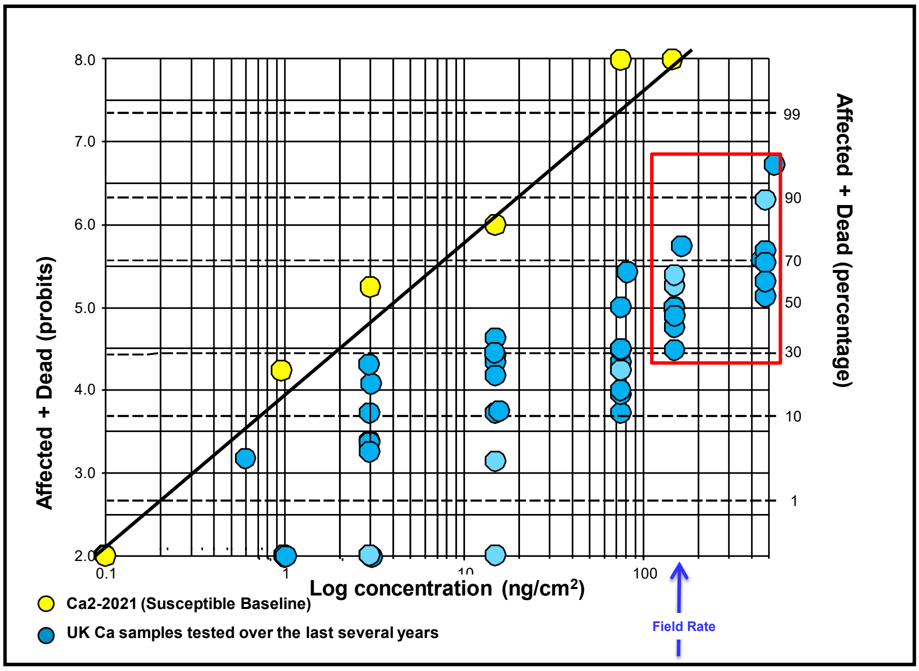

Figure 6. Response of *Cavariella aegopodii* to Lambda-cyhalothrin in coated glass vial assays (5 h end point)

Samples of the leaf hopper (*Psammotetix alienus*), collected from barley in the east of England in 2024, were screened for Wheat Dwarf Virus (WDV) and this virus was found in all of the individuals tested. Unfortunately, the adult leaf hoppers in this sample were not in a healthy-enough condition for evaluation in a live glass vial bioassay (where the unrtreated control mortality was above 20%) so could not also be screened for pyrethroid resistance.

Interestingly, the sampler (Alan Dewar, Dewar Crop Protection), informed us that there have been recent unusual virus yellowing symptoms in cereal crops on the Norfolk/Suffolk border (Breckland) which could have been transmitted by leaf hoppers. This observation has been supported by agronomists seeing these unusual crop yellowing symptoms in cereals. This suggests that this virus-transmitting leaf hopper pest, normally found abroad, is 'on the rise' in the UK and the potential escalation of this situation needs to be monitored closely in the future as it poses a new risk of virus transmission to UK cereals.

Summary of results from the reporting year

The number of UK live Insect samples, collected primarily by the sub-contractors (Dewar Crop Protection and ADAS) tested during the one year project extension (01/06/2023 to 31/04/2024), were:

- 13 peach-potato aphid samples (*M. persicae*)
- 5 grain aphids samples (*S. avenae*)
- 5 cabbage stem flea beetle samples (*P. chrysocephala*)
- 3 pollen beetle samples (*M. aeneus*)

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We made several significant discoveries during the past year, which will most probably impact on virus control in the UK in the future as they pose a real threat to crops grown in the UK. These discoveries are also summarised in the section of the report above. They involve a wide range of crops for the aphid pest, *M. persicae*, and cereal crops (wheat and barley) for *S. avenae* and *P. alienus*. These recent discoveries need further research.

Screening of 13 peach-potato aphid (*M. persicae*) samples, collected in 2023, primarily from oilseed rape, showed that there continued to be no reduced sensitivity or resistance (that may compromise insecticide-based control) to three insecticides available for use against this pest: Cyantraniliprole, Flonicamid and Spirotetramat.

In contrast, we continued to find strong pyrethroid resistance in the *M. persicae* samples to Esfenvalerate and Lambda-cyhalothrin in our screening bioassays (primarily conferred by the super-kdr, M918L/*Ne*, target site mechanism). Interestingly, aphids carrying this mutation in the homozygous (RR), form were seen for the first time.

We recorded the first ever finding of a UK *M. persicae* sample carrying strong Neonicotinoid (Nic-R^{++}) resistance. This sample was collected in Suffolk from oilseed rape in autumn 2023. This strong Neonic resistance phenotype was seen in separate screening bioassays applying Imidacloprid and Acetamiprid, where healthy aphids capable of producing viable nymphs were recorded (Figure 7). We have never seen this level of resistance before in all of our bioassays applied against UK *M. persicae* samples going back almost three decades, to when our Neonic testing commenced (in 1996).

This important finding of strong (Nic-R^{++}) resistance was supported by follow-up molecular assays disclosing that these aphids carry the recognised R81T target site mutation, known to be present in *M. persicae* in mainland Europe and most recently found in aphids on sugar beet in Belgium, a country geographically close to the UK (Mark Stevens, *pers. comm.*). Interestingly, these UK Nic-R^{++}aphids also carred the super-kdr mutation (M918L) in the homozygous (RR) form, a genotype never seen before. This means that neither Neonicotinoids or Pyrethroids will control these aphids. Micro-satellite testing, done at the James Hutton Institute (through 'in-kind' research), has shown that these aphids carry a unique genotype and are therefore most likely to have originated from abroad.

We need to establish, through further funding, the frequency and potential geographical spread of these aphids in the UK as this new strongly-resistant clone could well have a significant impact on virus control in UK crops, including oilseed rape, sugar beet and potatoes.

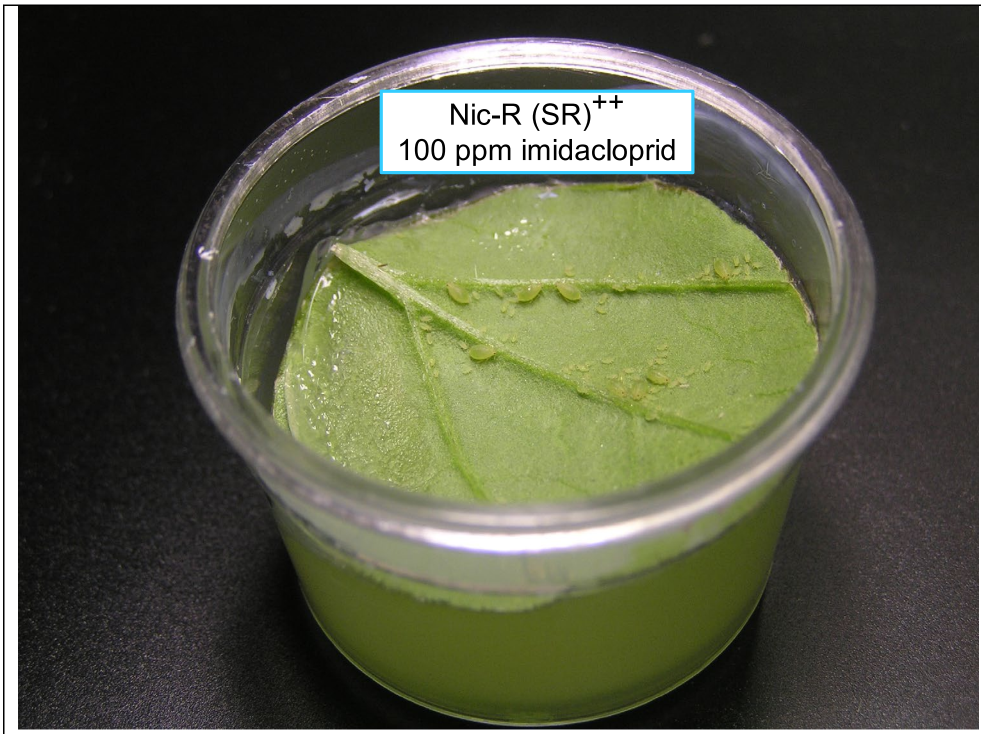

Figure 7. Response of UK *Myzus persicae* (2023) sample to 100 ppm screening dose of the Neonicotinoid, Imidacloprid. Dosed adults can be seen producing healthy, viable nymphs.

Three of the 2023 UK *M. persicae* samples contained aphids carrying extreme (R_3) esterase levels, conferring strong metabolic-based resistance to OPs, which are now rarely used in the UK. These metabolic-resistant forms have proved to be rare in the past in samples collected from open UK field crops. There is therefore the possibility that they originated from foreign countries, where OPs are used far more.

All of these recent changes in the resistance genetic make-up of the UK *M. persicae* population appear to be due to new aphid forms appearing in this country, most probably through aphids arriving from abroad.

M. persicae carrying MACE resistance (specifically to Pirimicarb), in the heterozygous (SR) form, were at higher levels than in 2022 (46% of the 2023 samples, Figure 8). This target site resistance mechanism has continued to be monitored in this project to assess if there are any potential fitness costs associated with it after the significant reduction in selection pressure following the loss of pirimicarbin the UK as a registered spray on most UK crops several years ago. Interestingly, our 2023 sample data suggest that there is no significant fitness cost imposed by MACE in *M. persicae* in this country.

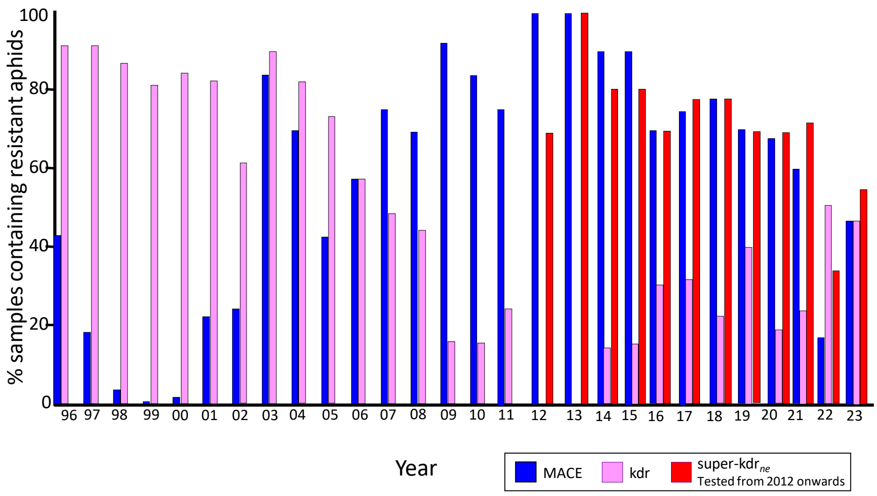

Figure 8. Frequency of *Myzus persicae* samples containing MACE, kdr and super-kdr (*Ne*) target site resistance in UK field samples.

Up until recently, we have shown that moderate pyrethroid resistance exists in the grain aphid, *S. avenae*, in the UK that should not compromise control if these insecticide sprays are applied at the full recommended 100% field rate (5 g ai/ha) and there is good contact with aphids on the crop. However, in April 2024 Alan Dewar (of Dewar Crop Protection) made Rothamsted aware that he had found *S. avenae* in cereal crops grown in eastern England in unprecedented high numbers for that time of year, including a cereal crop located in Norfolk that had received three pyrethroid spray applications. This observation suggested a control failure with pyrethroids and the possibility that this aphid pest had evolved pyrethroid resistance 'above and beyond' the moderate heterozygous (kdr-SR) target site level that we have found previously in samples collected and tested over the years in this project. In an aphid sample (3), collected from this wheat field, alongside four other *S. avenae* samples, we confirmed that it contained aphids carrying the kdr-SR genotype:

Sample 1: Hasse Fen, Ely, Cambs. kdr-SS
Sample 2: Fetwell, Cambs. kdr-SS
Sample 3: Narborough, Norfolk. kdr-SR
Sample 4: Breckles, Norfolk. kdr-SS
Sample 5: Saffron Walden, Essex. kdr-SS

Our molecular assays were followed up by testing aphids reared from *S. avenae* sample 3 in Lambda-cyhalothirn (coated glass vial) bioassays. These showed a higher Resistance Response above that seen in our bioassays in the past for standard kdr-SR genotypes, although the LC_{50} 95% confidence limits for this Norfolk sample overlapped with those for our kdr-SR standard clone. In addition, a recent development seen in a field spray trial including aphids reared from this 2024 Norfolk *S. avenae* sample showed that Lambda-cyhalothrin had poor control at the recommended 100% field spray rate, something that has not been seen before in the UK (A. Dewar *pers.*

comm.). These findings suggest the presence of strong pyrethroid resistance in grain aphids and need to be investigated further as they could have important implication for virus control in UK cereals. In the 14 English cabbage stem flea beetle (*Psylliodees chrysocephala*) samples collected at oilseed rape harvest and tested in 2023, 13 contained fully pyrethoid-resiatant adults, ranging from 7% to 95%. These are similar findings to English samples tested in the past several years. The one Scottish sample tested in 2023 contained 27% resistant beetles. This was the first time that pyrethroid resistance has been seen in Scotish CSFB samples as all previous testing for this country have contained fully-susceptible adults in the past several years. Three pollen beetle (*M. aeneus*) samples (collected from oilseed rape at Rothamsted in 2023) contained pyrethroid-resistant beetles at the 100% field rate. Resistance is therefore still present in this pest, though this is in a limited number of tested samples and restricted location. This resistance is thought to be primarily conferred a metabolic P450 mechanism.

Key issues to be addressed in the next year
In the next year, we aim to screen pest insect samples of aphids, beetles and, potentially, other relevant species in response to any reports of insecticide control failures. Specifically, the species to prioritise are cereal aphids, peach-potato aphids, cabbage stem flea beetles, pollen beetles and leaf hoppers.

Lead partner	Rothamsted Research
Scientific partners	James Hutton Institute ('in kind' contribution for Micro-satellite testing on *M. persicae* samples)
Industry partners (for reporting year)	Agrii, AHDB, AICC, BASF, Bayer, BBRO, Certis-Belchim, Corteva, FMC Agro, Frontier, Hutchinsons, NuFarm, Procam, Sumitomo and Syngenta
Government sponsor	Defra/CRD 'in kind' contribution

Events	*Press articles*
S Foster. Insecticide resistance management. *AHDB Cereals and Oilseeds Monitoring Meeting.* Virtual Meeting via Teams. June, 2024. A Dewar. Current resistance status of BYDV transmitting cereal aphids, and their population dynamics, in the UK . *Agri Web Media, on behalf of seed breeder RAGT*. Lichfield, Birmingham, June 2024. S Foster. Monitoring and managing insecticide resistance in UK pests. *IRAG-UK Meeting*, AHDB Headquarters, Coventry, May, 2024. A Dewar. Control of Arable pests, especially vectors of BYDV. *Apex Agronomy Group*, Slamseys Farm, Great Notley, Essex, February 2024.	..

S Foster. Insect pest resistance monitoring project. *AICC Annual Conference*, Towcester, January, 2024. S Foster. Monitoring and managing insecticide resistance in UK pests. *IRAG-UK Meeting*, Virtual Meeting via Teams, December 2023.	
Conference presentations, papers or posters	***Scientific papers***
See Above	
Other	

Resistance Management Guidelines and Resistance Alerts (in last year)

These Guidelines have been updated, primarily via IRAG-UK and the AHDB Websites, based on our latest findings from this Project:

Revision to *IRAG-UK Guidelines*: Insecticide resistance status in UK cereal crops (2024)
Revision to *IRAG-UK Guidelines*: Insecticide resistance status in UK oilseed rape crops (2024)
Revision to *IRAG-UK Guidelines*: Insecticide resistance status in UK brassica crops (2024)
Revision to *IRAG-UK Guidelines*: Insecticide resistance status in UK potato crops (2024)

Articles in Farming and Popular Press

Insecticide resistance: a major concern facing the tillage sector (*Agriland*, September 2023)

A place for pyrethroids? (*Crop Production Magazine*, August 2023)