Combatting Resistance to Aphicides in UK Aphid Pests

Project number	RD-2011-3768		
Start date	01/04/12	**End date**	31/3/15

Project aim and objectives

The project is continuing research on aphicide resistance management for the UK farming industries and providing up-to-date information for agronomic and regulatory procedures. The need for this work is heightened by the occurrence of control failures with neonicotinoids against peach-potato aphids, *Myzus persicae*, in southern mainland Europe. The appearance of these resistant aphids in that region represents a substantial threat to aphid control in the UK as any move into the UK would have very serious repercussions for neonicotinoid treatments on a range of crops and loss of effective neonicotinoids and a move to other chemistry would accentuate the risk of the evolution of resistance to the alternative non-neonicotinoid compounds.

The project is monitoring the response of live samples of *M. persicae* (collected from field and protected crops) to a range of novel aphicides and also screening for established forms of resistance using DNA-based techniques. This close vigilance is essential to safeguard the contribution of these compounds to aphid pest management in the UK as resistant aphids that cannot be controlled by insecticides will inevitably cause crop losses. Other important aphid pests (potato aphids, *Macrosiphum euphorbiae*, currant-lettuce aphids, *Nasonovia ribisnigri*, and grain aphids, *Sitobion avenae*) representing the interests of the project consortium are also being monitored, and baseline bioassay data established for relevant insecticides for these and other important aphid pests.

New bioassays for use as screening tools for novel aphicides are also being developed for use in regional laboratories or by advisors and growers.

The continued work is highly relevant to the policy objectives of Defra-CRD, and the co-ordination of research and decision making among agrochemical companies, farmer and grower organisations and advisors. Its importance is enhanced by recent EU-imposed restrictions on neonicotinoid use, which will possibly continue past the current two year period and may extend to other insecticide classes, coupled with the resistance situation for existing insecticides in *M. persicae*.

The over-riding objective of the project is to retain the availability of effective pesticides by developing appropriate Aphid Management Strategies and providing robust scientific support to the regulatory decision making process. Guidance is available to advisors, growers and the scientific community through the Insecticide Resistance Action Group (IRAG-UK). Other routes of communication include articles in the trade press, presentations to growers and agronomists, and papers in referred journals (see below for 2014 outputs).

Key messages emerging from the project

- Screening of *M. persicae* samples taken from the field and protected crops in 2014 showed that there continues to be no significant resistance (that may compromise control) to a range of newer compounds belonging to different chemical classes. Furthermore, there have been no significant shifts in response to diagnostic doses of newer insecticides that are currently effective (un-resisted) in the UK.
- Strong pirimicarb resistance and pyrethroid resistance (conferred by MACE and super-kdr target site mechanisms respectively), remain prevalent in the *M. persicae* samples. However, resistance was not detected in samples of other aphid pests such as *M. euphorbiae*.
- Our findings continue to suggest that at least some aphids in *M. persicae* samples from protected crops may have come from more genetically-diverse, sexual populations on imported plant material. Collecting samples from these environments remains particularly important as they are more likely to harbour aphids with new resistance mechanisms (e.g. to neonicotinoids) imported from overseas.
- The baseline work on important aphid pests other than *M. persicae* continues to add data to the large database and will allow pests that are involved in future reports of insecticide control problems to be quickly screened for potential resistance (not seen before).

The results described in this summary report are interim and relate to one year. In all cases, the reports refer to projects that extend over a number of years.

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Summary of results from the reporting year

- In 2014, Rothamsted received and successfully reared *M. persicae* samples from 21 field and 7 protected crop sites in England (collected by Dewar Crop Protection, ADAS and from other sources).
- Screening by bioassay of live aphids from these samples continued to show no resistance to neonicotinoids, pymetrozine, flonicamid, spirotetramat or cyantraniliprole (the latter is not currently registered in the UK). Furthermore, there have been no significant reductions in mortality at diagnostic doses of newer insecticides.
- MACE resistance (to pirimicarb), in the heterozygous form, continues to be common and widespread in *M. persicae* in the UK.
- There is currently a very high frequency of *M. persicae* with the new form (north European: *ne*) of super-kdr in the heterozygous state (which we have previously shown to confer strong resistance, measured by survival, to some pyrethroids). These are primarily aphids with the very common 'O' and 'P' micro-satellite genotypes which also carry MACE. It is unlikely that these super-kdr aphids are repelled by pyrethroids.
- *M. persicae*, as predicted, flew two to four weeks earlier than usual in 2014. This was mainly due to the mild winter, helped by the favourable conditions of spring. However, the very wet winter did not have a significant effect on the 'O' and 'P' types which continue to be well adapted for cold and wet weather UK weather.
- *M. persicae* males caught in suction traps in the spring were all 'P' types showing that this clone is andro-cyclic (male producing).
- In the field samples there continues to be an extremely low frequency of *M. persicae* with high (R_2) or extreme (R_3) esterase resistance to organophosphates (OPs) which is most likely due to the lack of use of these compounds in the UK and fitness costs associated with this resistance mechanism.
- A comparison of the resistant *M. persicae* genotypes found in the field and protected crops over recent years, suggests that aphids with rarer combinations of resistance mechanisms/genotypes (including higher R_2/R_3 esterase-based resistance and homozygous MACE, kdr and super-kdr aphids) are found more often in the protected crops with some not being seen at all in some years in the field in the UK. This could be due to aphids in the protected environments originating from more diverse, foreign populations probably on imported plant material. Having said this, Nic-SR/RR or super-kdr$_{se}$ (southern European mutation), which appear to be largely restricted to peach orchards, have so far not been seen in the protected UK samples.
- Numbers of *M. persicae* caught in yellow water traps at Fulbourne (Cambridgeshire) continued to be extremely high in 2014 compared to other trap sites, with 658 aphids arriving between 21st to 27th May compared to less than 50 aphids at all the other sites. A visit to the Fulbourne site revealed that the four traps were situated in a beet field close to a very large field of mature oilseed rape which was supporting a large *M. persicae* population.
- There was no evidence for increased resistance to pirimicarb in the *M. euphorbiae* samples received in 2014. However, recent samples have contained aphids with reduced sensitivity to pymetrozine compared to the susceptible baseline. We must therefore be vigilant for any further shifts in sensitivity to this compound in this pest.
- We have continued developing and validating the best bioassay method for various insecticide/aphid species combinations with the end product of susceptible baselines.

Key issues to be addressed in the next year

Assuming that the extension period is agreed, the project will continue to monitor the response of live samples of *M. persicae* (collected from field and protected crops) to a range of aphicides using screening bioassays; an important approach as we cannot predict the mechanism of new types of resistance. It will also continue to monitor for established forms of resistance using DNA diagnostics. This close vigilance is essential to safeguard the contribution of effective compounds to aphid pest management.

We will also continue to monitor other important aphid pests, and continue to establish useful insecticide-susceptible baseline data for additional pest/insecticide combinations to allow quick screening for resistance in samples associated with control failures.

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Three new objectives in the extension will replace two of the original objectives (simulator-based measurements of resistance to neonicotinoids and pymetrozine and development of glass vial bioassays) that are or will be completed by 31/3/15. The new ones are:

1) Further studies on the fitness of *Sitobion avenae* with kdr,
2) Responding to reports of pyrethroid control failures against aphids on cereals, and
3) Determining resistance of super-kdr *Myzus persicae* to different pyrethroids.

Lead partner	Rothamsted Research
Scientific partners	Rothamsted Research
Industry partners	Bayer, Belchim, DuPont, NuFarm, Sumitomo/InterFarm, Syngenta, AHDB-HGCA, AHDB-Horticulture, AHDB-Potato Council, BBRO.
Government sponsor	Chemicals Regulation Directorate/Defra.

Has your project featured in any of the following in the last year?

Events

See Conference presentations, papers or posters

Press articles

Controlling aphids and virus diseases in cereals and oilseed rape (*HGCA e-newsletter*, October)
Now the chickens will come home to roost (*Outlooks on Pest Management,* August)
No peach–potato aphids (*HGCA Press Release*, August)
Aphid resistance (*Bayer Website*, May)
Brassica Pests (*Brassica Pest Bulletin*, May) Aphids to make an early landing in 2014 (*Bayer CropScience Magazine: Four Seasons Potatoes*, April)
Annihilating the aphids (*The Herts Advertiser*, May)
Aphids to make an early landing in 2014 (*CPM Magazine*, April)
Aphid resistance to insecticides (*Irish Farmers Journal*, February)
Neonicotinoids ban makes pest control harder for OSR (*Farmers Weekly*, January)

Conference presentations, papers or posters

Presentations:

S Foster. Combating resistance to aphicides in UK aphid pests. *IRAG-UK*, Harpenden, November 2014.
C Nicholls. Pest monitoring and control. *HGCA Agronomist Intake Day*, Huntingdon, November 2014.
R Harrington, S Foster & M Williamson. The resistance trap – growing aphid threats. *Crop Protection in Southern Britain*, November, 2014.
R Harrington. Aphid monitoring and insecticide resistance. *Potato Council Crop Protection Treater Group*, York, November 2014.
L Field. Insect control – what are the issues? *Herts NFU Branch Meeting*, Ferny Hill Farm, Hertfordshire, October 2014.
B Fenton, G Malloch, M Williamson & S Foster. *Sitobion avenae* – the grain aphid: could it become a threat to your seed potato crop? *Potatoes in Practice Seminar*, Dundee, August 2014.
I Denholm, S Foster & M Williamson. No sex please, we're British: resistance behaving badly! *Symposium for Ralf Nauen*, San Francisco, August 2014.
S Foster. Insecticide resistance in aphids. *European Congress of Entomology*, York, August 2014.
S Foster. Pyrethroid resistance in the grain aphid, *Sitobion avenae. Bayer Press Meeting*, Cambridge, May 2014.
G Malloch. *Sitobion avenae* – the grain aphid: is it a new vector threat to your potato crop? *Scottish Society for Crop Research: Potato Committee: Winter Meeting*, James Hutton Institute, Dundee, March 2014.

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S Foster. Combating resistance to aphicides in UK aphid pests. *IRAG-UK*, Wellesbourne, March 2014.
A Dewar, M Williamson & S Foster**.** Alternative insecticides to control cereal aphid, *Sitobion avenae*, that are resistant to pyrethroids. *Crop Protection Conference in Northern Britain*, Dundee, February 2014.
C Nicholls. Life after neonicotinoids. *United Oilseeds/HGCA Oilseeds Update Seminar*, Northampton, February 2014.
S Foster. Insecticide resistance in grain aphids. *National Tillage Conference*, Kilkenny, January 2014.
A Dewar. The consequences of the neonicotinoid ban for control of flea beetles and aphids in oilseed rape. *AICC Annual Conference*, Towcester, January 2014
Eric Anderson. Evaluating the effectiveness of mineral oils in minimising the spread of non-persistent viruses in potato seed crops in Great Britain. *Potato Council Meeting*, SASA, Edinburgh, January 2014.

Scientific papers

C Bass, M Puinean, CT Zimmer, LM Field, S Foster, R Nauen, R Slater, MS Williamson. The evolution of insecticide resistance in the peach potato aphid, *Myzus persicae. Insect Biochemistry and Molecular Biology*, **31**, 41-51.

Other

Aphid Alert: oilseed rape, aphids and flea beetles without neonicotinoids. In AHDB News (2014).
Revision to HGCA Information Sheet: Controlling aphids and virus diseases in cereals and oilseed rape. Information Sheet 32 (2014).
Practical measures to prevent and manage insecticide, fungicide and herbicide resistance for horticultural crops (2014).

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