Combating resistance to aphicides in UK aphid pests

Project number	RD-2011-3768		
Start date	Apr 2012	**End date**	Mar 2015

Project aim and objectives

Main aim:
To continue research on aphicide resistance management for the UK farming industries and provide up-to-date information for agronomic and regulatory procedures.

Objectives:

- To monitor the response of live samples of *M. persicae* (collected from field and protected crops) to a range of novel aphicides and also screen for established forms of resistance. Also, to monitor 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, and establish baseline bioassay data for relevant insecticides for these and other important aphid pests.
- Develop new screening tools for novel aphicides for use in regional laboratories or by advisors and growers.
- To retain the availability of effective pesticides by developing appropriate aphid management strategies and providing robust scientific support to the regulatory decision-making process.

Key messages emerging from the project

- The relatively low number of field samples of *M. persicae* tested in 2013 was due to the very late spring (latest for 50 years) and wet autumn. This was compensated for by the collection and testing of more samples from protected crops than in previous years.
- There continues to be no evidence of 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 un-resisted in the UK.
- Strong pirimicarb resistance and pyrethroid resistance remained prevalent in the *M. persicae* samples but not in samples of other aphid pests, such as *M. euphorbiae* (potato aphid).
- Our findings suggest that 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 is important as they are more likely to harbour aphids with new resistance mechanisms imported from overseas. Aphids in protected crops also breed faster than those on field crops due to higher temperatures and can, therefore, be treated more frequently with pesticides, which increases the risk of resistance development.
- Resistance Factors (RFs) shown by neonicotinoid-resistant SR (heterozygote) and RR (homozygote) *M. persicae* depend on the route of treatment (topical vs systemic) and the type of response being measured (survival vs ability to reproduce). This has implications for which resistance genotypes are ultimately found in the UK and whether control measures use seed treatments (which are currently restricted on some crops through EU legislation) or sprays.
- 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.

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.

Annual Project Report 2013

Summary of results from the reporting year
- In 2013, Rothamsted received and successfully reared 12 field and 8 protected *M. persicae* samples (collected by Dewar Crop Protection and ADAS). - Screening of live aphids from these samples showed no resistance to neonicotinoids, pymetrozine, flonicamid, spirotetramat or cyantraniliprole (the latter is not currently registered in the UK). - MACE resistance (to pirimicarb) continues to be very common and widespread in *M. persicae* in the UK. - There is currently a very high frequency (> 90%) on field crops of *M. persicae* carrying a new form of super-kdr in the heterozygous form (which we have shown to confer strong resistanceto some pyrethroids). These are primarily aphids with the very common 'O' and 'P' micro-satellite genotypes, which also carry MACE. It is currently unknown if these super-kdr aphids are repelled by pyrethroids. - In the field samples, there continues to be an extremely low frequency of *M. persicae* carrying high (R2) or extreme (R3) esterase resistance to organophosphates (OPs), which is most likely due to the disuse of these compounds in the UK and fitness costs associated with resistance. This is in contrast to *M. persicae* in mainland Europe, where samples have contained R2 and R3 aphids. This is probably because OP usage tends to be much greater in this region. - Compared with field samples, esterase-R2/R3 aphids were more common in the protected samples (collected from crops grown in glasshouses and polytunnels). These samples also contained *M. persicae* with rarer combinations of resistance genotypes (not seen in the field populations in the UK and implying a non-UK origin). - Neonicotinoid-resistant SR (heterozygote) and RR (homozygote) *M. persicae* standard clones (collected from mainland Europe) showed strong resistance in topical bioassays applying imidacloprid with RFs relative to the susceptible baseline >8000 ppm. Interestingly, the highest dose at which adults produced viable offspring was also in the 1000s for the RR aphids but was only 30 ppm for the SR aphids, highlighting the value of being able to distinguish between genotypes. - We have continued developing and validating the best bioassay method for various insecticide/aphid species combinations to make susceptible baselines. - Control experiments revealed endpoints of up to 48 h for a topical glass approach for screening the response of *M. persicae* to different insecticides.

Key issues to be addressed in the next year
Continue to monitor the response of live samples of *M. persicae* (collected from field and protected crops) to a range of aphicides. It will also continue to monitor for established forms of resistance using DNA diagnostics. Other important aphid pests will also be monitored, and we will 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.

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

Annual Project Report 2013

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

Events	***Scientific papers***
Cereals 2013	SP Foster, VL Paul, R Slater, A Warren, I Denholm, L Field & MS Williamson. A mutation (L1014F) in the voltage-gated sodium channel of the Grain aphid, *Sitobion avenae*, associated with resistance to pyrethroid insecticides. *Pest Management Science.* In Press.
Press articles	***Conference presentations, papers or posters***
Neonicotinoid insecticides - a review of their contribution to the sugar beet crop. British Sugar Beet Review Winter Issue 81 (4) 27-29. Mild weather could heighten aphid risk (Farmers Weekly, November). Growth in weed and pest resistance spells trouble (Farmers Weekly, October). State of play: pests and weeds (Crops Magazine, October). Research project aims to enhance aphid prediction (Farmers Weekly, September). Monitoring service gives prior warning of aphids (Crops Magazine, September). Tough prospects for OSR? (CPM Magazine, July). FV 344a (LK 09114) Combating Resistance to Aphicides in UK Aphid Pests (HDC Field Vegetables Review Magazine, July). Combating resistance to aphicides in UK aphid pests (HDC Field Vegetables Review Magazine, June). Rothamsted Research prediction for M. persicae (peach-potato aphid) in 2013 (Syngenta Brassica Technical Bulletin, April). Pyrethroid resistance 'main cause of Barley Yellow Dwarf Virus' (Farmers Weekly, January).	Presentations: S Foster. Managing insecticide resistance: the good, the bad and the ugly. *HGCA Agronomists' Conference*, Peterborough, December 2013. L Field and S Foster. Insecticide resistance. *The Alpha Group*, Rothamsted Research, November 2013. S Foster. Update on insecticide resistance in *Myzus persicae* and *Sitobion avenae. Aphid Special Interest Group Meeting*, Leamington Spa, September 2013. C Shorthall. Going against the grain aphid. *9th International Aphid Symposium*, Beijing, June 2013. S Foster. Insecticide resistance in aphids: benefits and drawbacks. *Newcastle University Seminar.* Newcastle upon Tyne, May 2013. S Foster. Update on the work of IRAG-UK. *48th Meeting of IRAC International*, Jealott's Hill, Berkshire, March 2013. S Foster. The dynamics of insecticide resistance and its implications for IRM. *48th Meeting of IRAC International*, Jealott's Hill, March 2013. A Dewar. Controversial issues for pest control in arable agriculture. *Crop Advisors Alliance Annual Conference*, Sutton Scotney, Hants, February 2013. L Field. Insecticide resistance in aphids. *BBRO Winter Conference*, Peterborough, February 2013. E Anderson. Aphicide programmes and virus control in seed crops - A state of flux. *Bayer Crop Science Potato Conference*, Peterborough, January 2013. M Stevens. Aphid and virus control in the arable rotation: current status and future issues. *AICC Winter Conference.* Towcester, January 2013. A Dewar. Resistance of grain aphids to pyrethroids. *AICC Winter Conference.* Towcester, January 2013.

	Posters: S Foster & M Williamson. Monitoring resistance to aphicides in the peach-potato aphid, *Myzus persicae*. *AHDB Research Conference.* London, September 2013.
Other	
Revision to: IRAG-UK Resistance Alert: Knock-down resistance (kdr) in grain aphids (2013). Revision to: Guidelines for preventing and managing insecticide resistance in aphids on potatoes (2013).	