

Studentship Project: Annual Progress Report 09/2022 to 09/2023

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Project Title:	Attacking the clones: understanding aphid pest resistance to biological control.		
Lead Partner:	Harper Adams University		
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Start Date:	27/09/2021	End Date:	26/09/2025

1. Project aims and objectives

The potato aphid (*Macrosiphum euphorbiae*) is an economically important pest of strawberry crops in the UK. The presence of this aphid and the honeydew it produces can affect plant photosynthesis by promoting fungal growth (sooty moulds), affecting fruit formation and its marketability. Integrated pest management in strawberry crops is focused on the use of biological controls for different pests and the minimal use of synthetic chemical insecticides. In the case of aphids, individual or a mix of six aphid parasitoid species are currently used in both protected and outdoor crop environments. However, there has been an increase in the frequency of reports of early-season control problems of potato aphids in strawberry crops. Parasitoid resistance in aphids has been reported for different species including the potato aphid in potato crops in the UK, however, aphid resistance to parasitoids has not been confirmed to be a problem in strawberry crops. Aphid resistance to parasitoids can be genetically encoded or a trait conferred by facultative bacteria living inside the insects. The main objective of this project is to understand the role of potato aphid clonal diversity on its interactions with parasitoids used in biological control programmes in strawberry crops. The specific aims of this project are:

- 1) Determine the clonal diversity of the potato aphid attacking strawberry crops in the UK.
- 2) Understand the role of aphid genetics and secondary endosymbiont composition on variability of potato aphid susceptibility to parasitoids.
- 3) Determine the genetic diversity of the main parasitoid species (*Aphidius ervi*) used against potato aphid, as supplied by different biological control companies, to understand whether genetic diversity can be used to overcome aphid resistance to this parasitoid species.
- 4) To test under commercial crop conditions whether genetic variation in the potato aphid and the endosymbionts they carry confers resistance to released parasitoids, by assessing how the aphid-endosymbiont-parasitoid community dynamic fluctuates through the season.

2. Key messages emerging from the project

1. There is genetic diversity of *Macrosiphum euphorbiae* infesting strawberry crops grown in the UK.
2. Different clonal lines of *Macrosiphum euphorbiae* are infected by single, double or triple infections of secondary endosymbionts including: *Hamiltonella defensa*, *Serratia symbiotica*, *Regiella insecticola*, *Rickettsia* sp.

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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3. Different clonal lines of *Macrosiphum euphorbiae* collected from strawberries in the UK have shown variability on their susceptibility to the parasitoid *Aphidius ervi* provided by a commercial supplier.
4. The genetic background of *Macrosiphum euphorbiae* influences certain aphid defensive behaviours and has an effect in some parasitoid host searching behaviours.
5. The genetic background of *Macrosiphum euphorbiae* is not a factor in the variability of aphid susceptibility to *Aphidius ervi* provided by a commercial supplier.

3. Summary of results from the reporting year

Parasitism assays were completed for the 14 clonal lines. Data from these parasitism bioassays showed significant differences in parasitoid susceptibility between the 14-potato aphid clonal lines, with two lines from Staffordshire where a parasitism proportion <20% to the parasitoid *A. ervi* provided by a commercial supplier was recorded.

Subsequently, a more detailed assay with two clonal lines per genotype was undertaken to understand the role of aphid genotype in determining potato aphid susceptibility to *A. ervi*, aphid defensive behaviours and the effect on parasitoid host selection behaviours. The results showed no effect of genotype on parasitism proportions, nor for parasitoid acceptance for oviposition. However, an effect of clonal line on the number of ovipositor probes and parasitoid acceptance was recorded. An effect of genotype on aphid defensive behaviours such as kicking and dropping/jumping was also described. A clonal line effect was detected for all defensive behaviours except for running. In addition, the effect of genotype on parasitoid cleaning time, antennal orientation time, and antennal examination time was recorded. There was also a clonal line effect on walking time, antennal orientation time and antennal examination time.

Our results so far show that variability in susceptibility of potato aphid to *A. ervi* exists in strawberry crops, and that the role of aphid genotype is complex, but it is apparently overshadowed by the effect of clonal line. The role of endosymbionts as part of clonal line variation, however, is still to be investigated.

4. Key issues to be addressed in the next year

- A second parasitism assay investigating the role of other origins of clonal variation on the aphid-parasitoid interaction, such as endosymbiont composition, should be undertaken.
- Getting field data from one or two strawberry seasons, in terms of potato aphid presence, genotype composition, endosymbiont composition and parasitism pressure, should also be included.
- Genotyping of commercial parasitoid lines must be also undertaken to understand the intra-specific variation of the biological controls currently applied to the fields.

5. Outputs relating to the project

(events, press articles, conference posters or presentations, scientific papers):

Output	Detail
CTP Winter Event presentation	“Attacking the clones: understanding resistance of aphid pests to biological control” Update on the project.
Royal Entomological Society Student Forum presentation	“Potato aphid (<i>Macrosiphum euphorbiae</i>) clonal variation determines its susceptibility to <i>Aphidius ervi</i> ” Oral presentation
CTP Summer Event presentation	“Attacking the clones: understanding resistance of aphid pests to biological control”

	Update on the project.
IOBC Meeting “Integrated Control in Protected Crops, Temperate Climate and Mediterranean Climate” presentation in Brest, France.	<p>“Clonal differences in the potato aphid (<i>Macrosiphum euphorbiae</i>) determine responses to an aphid parasitoid”</p> <p>Oral presentation</p>
Harper Adams University Research Conference presentation.	<p>“Clonal differences in the potato aphid (<i>Macrosiphum euphorbiae</i>) determine responses to an aphid parasitoid”</p> <p>Oral presentation</p>
Paper under review in the Insect Science journal.	“The clip cage conundrum: assessing the interplay of confinement method and aphid genotype in fitness studies”

6. Partners (if applicable)

Scientific partners	The James Hutton Institute, NIAB East Malling,
Industry partners	Berry Gardens Ltd.
Government sponsor	BSSRC