

Studentship Project: Annual Progress Report 09/2023 to 09/2024

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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 but it is not a factor in the variability of aphid susceptibility to *Aphidius ervi* provided by a commercial supplier.
5. Infection of *Macrosiphum euphorbiae* with certain secondary endosymbionts influences some parasitoid host searching behaviours, parasitoid acceptance and susceptibility to *Aphidius ervi* provided by a commercial supplier.
6. There is little genetic differentiation between *Aphidius ervi* wasps supplied by different commercial suppliers.
7. There is a high genotypic diversity and endosymbiont infection statuses among aphids attacking strawberry crops.

3. Summary of results from the reporting year

Parasitism assays were completed using the 14 aphid 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 genotype on aphid defensive behaviours such as kicking and dropping/jumping was also described. In addition, the effect of genotype on parasitoid cleaning time, antennal orientation time, and antennal examination time was recorded. A second assay with two clonal lines per endosymbiont infection status (i.e. *Hamiltonella defensa*, *Serratia symbiotica*, *Regiella insecticola*, no infection) showed an effect of endosymbiont infection status on parasitism proportion, acceptance and oviposition. Limited effect of infection status was recorded for aphid defensive behaviours, however there was a significant effect on certain parasitoid searching behaviours as walking time, antennal orientation and antennal examination. These results show that variability in susceptibility of potato aphid to *A. ervi* exists in strawberry crops, and that it is a complex trait. This also suggests that both aphid genotype and endosymbiont can have an effect on parasitoid searching for hosts, however there is a stronger link of endosymbionts infection with parasitism outcomes under laboratory conditions.

In terms of the parasitoid *Aphidius ervi* itself, it has been established that there was a low genetic diversity in the wasps supplied at the beginning of the season by commercial companies in the UK. There was also, low genetic differentiation between the different commercial suppliers. This can influence the effectiveness of parasitoid populations against aphid populations with variation in traits such as parasitoid susceptibility. A second assessment will be undertaken after the summer.

Finally, the results from the 2023 field survey so far have shown that there is a high genotypic diversity of the potato aphid attacking strawberry crops. It is important to notice that most of the genotypes showed low abundances and poor representation throughout the year. However, one genotype was deemed of importance as it was present throughout the whole season with high relative abundances. In terms of secondary endosymbionts, a mix of uninfected aphids and single and multiple endosymbiont infections were found throughout the season with a dominance of *Regiella insecticola* at the end of the season. This same survey is currently being repeated for the 2024 season.

4. Key issues to be addressed in the next year

- Getting field data from a second strawberry season, in terms of potato aphid presence, genotype composition, endosymbiont composition and parasitism pressure, should also be included.

- A second genetic assessment of commercial parasitoid lines must be also undertaken to understand the intra-specific variation of the biological controls currently applied to the fields.
- A parasitism assay investigating the differences of the commercial *Aphidius ervi* parasitoid lines on potato aphid clonal lines with different susceptibility levels should be undertaken to understand better the link of genetic diversity of the wasps on their effectiveness as biological control agents.

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 Aphid SIG event	“The role of aphid genotype on potato aphid 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.
Harper Adams University Research Conference presentation.	“Is there a link between genotypes, endosymbionts and parasitoids of the potato aphid on strawberry crops?” Oral presentation
Paper accepted in the Insect Science journal.	“The clip cage conundrum: assessing the interplay of confinement method and aphid genotype in fitness studies”
Ento24 Royal Entomological Society.	“Is there a link between genotypes, endosymbionts and parasitoids of the potato aphid on strawberry crops?” Oral presentation
Paper accepted in Ecological Entomology.	“The influence of genetic variation on pre-oviposition processes for host-parasitoid co-evolution”

6. Partners (if applicable)

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