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Project number:	SFTF 170
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The results and conclusions in this report are based on an investigation conducted over a one-year period. The conditions under which the experiments were carried out and the results have been reported in detail and with accuracy. However, because of the biological nature of the work it must be borne in mind that different circumstances and conditions could produce different results. Therefore, care must be taken with interpretation of the results, especially if they are used as the basis for commercial product recommendations.

AUTHENTICATION

We declare that this work was done under our supervision according to the procedures described herein and that the report represents a true and accurate record of the results obtained.

Cindayniah Godfrey

PhD Student

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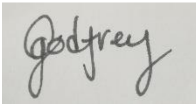
Signature ....  .... Date 30.10.20

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GROWER SUMMARY

Headline

This project seeks to improve understanding of known woolly apple aphid resistance genes and to identify potential resistance genes from novel sources to include in a breeding programme. This project also aims to improve knowledge of woolly apple aphid lifecycle in the UK to better understand the pest.

Background

Woolly apple aphid (WAA; *Eriosoma lanigerum* Hausmann.) is an aphid originating from North America which has now spread across the world. In North America WAA has a sexual lifecycle, alternating between apple and American Elm (*Ulmus americana* L.) but in the rest of the world WAA has an asexual lifecycle feeding exclusively on apple. In the orchard WAA can overwinter on roots and low branches as early instar nymphs, which disperse to the rest of the plant in the spring, forming colonies which persist through the summer, especially on young growth and injury sites.

Woolly apple aphid saliva causes cells in the vascular tissue to rapidly divide, creating galls in plant tissue which reduce plant growth by disrupting water and carbohydrate flow, and through tissue disruption. The galls created by root-feeding WAA can affect above-ground growth, even in mature trees, and can have a knock-on effect on reducing fruit set. These galls often crack, especially after cold conditions, creating open wounds which are vulnerable to secondary infection, for example from European apple canker.

Chlorpyrifos and pimiricarb were used to control WAA until their withdrawal in 2016, although insecticides containing spirotetramat, for example Batavia, are still authorized for use. Spirotetramat is a systemic pesticide and can affect WAA feeding on the roots, even when applied to the above-ground parts of the plant. There are some natural enemies of WAA, such as the parasitoid wasp *Aphelinus mali* (Haldeman.) and several predators e.g. hoverfly larvae and earwigs. Unfortunately, natural enemies have not been recorded predating or parasitising the below-ground aphids. Resistant rootstocks offer an option to control these aphids, and ideally would be part of an Integrated Pest Management (IPM) strategy. Whilst resistant rootstocks can control below-ground WAA, other control methods, such as the use of *A. mali*, can be used to tackle WAA feeding above ground. There is then still the option to use conventional chemical pesticides where necessary for control.

Approximately ten *Malus* cultivars have been reported as showing WAA resistance and four distinct resistance-mediating genes have been identified. The gene *Er1* is derived from the cultivar ‘Northern Spy’ and is the gene responsible for WAA resistance in the Malling-Merton (M.M.) rootstock series. This gene was the target of some work during the first year of the project.

Conventional plant breeding can take up to twenty-five years to bring a desirable trait to commercial introduction, especially for pest resistance. Marker-assisted selection (MAS) involves using the presence/absence of a marker linked to the target gene to identify whether the plant is resistant or susceptible, allowing quick and easy classification of any individual plant, making breeding programmes faster and more accurate.

Summary

In the first year of the project work focused on two main elements: mapping the resistance gene *Er1* and searching for potential novel sources of resistance within a range of crab apple species and domestic accessions. Both elements used similar methodology to achieve this year’s outcomes.

The second element of this year’s work was to take several crab apple species and accessions of domesticated apple and assess them for potential WAA resistance. Those which showed some resistance to WAA feeding will be used in the rest of the project to look at how resistance plants prevent aphid feeding, and the knock-on effects on growth and reproduction. A total of forty-one species of crabapple and domesticated apple accessions were phenotyped for WAA resistance. Of which, twelve were found to be WAA susceptible, eighteen resistant, and eleven as intermediate between resistant and susceptible.

To better understand how to control WAA in orchards it is important to understand its lifecycle in the UK and how it responds to feeding on different cultivars. To determine how the life cycles of populations of WAA around the world and within the UK differ, samples of WAA from different populations have been collected for genetic analysis. Sexually reproducing populations are expected to show higher genetic diversity than asexually reproducing populations, which may be a straightforward way of determining whether there is any sexual reproduction in the UK; it is currently thought that there is not.

Financial Benefits

This report summarises only the first year of a four-year project. As such there are no clear financial benefits yet outlined.

Action Points

There are no actions points from the first year of this project, as it is still in its early stages.