Project report for SSCR-Potatoes

***Project title*:**

Does integrated management influence aphid biocontrol on potato?

Applicant(s):

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Background to the project

A frequent pest of cultivated potato is the phloem-feeding potato aphid, *Macrosiphum euphorbiae* (Thomas). Aphids are the most important invertebrate herbivores in agriculture (Babikova et al., 2014), causing yield losses by its direct feeding (35-40 %) and the transmission of plant diseases (20-80 %). The composition and activity of soil microbes associated with plant roots (=the rhizosphere microbiome) has been reported in several studies to have an impact on insect herbivores and their natural enemies. Moreover, agricultural practices such as tillage and fertiliser application can influence the aboveground fauna (Bezemer et al., 2005).The Centre for Sustainable Cropping (CSC) based at Balruddery Farm is a long-term platform for research on agricultural sustainability based on six-year rotation of commonly grown arable crops in the region. The platform compares conventional and integrated management systems, which have been shown to differentially affect soil fertility, erosion and soil microbial activity and diversity (Liu et al., 2007).This study will assess the effects of soil management on the success of a common natural enemy of potato aphids in relation to changes in rhizosphere microbiome communities. Better understanding of the direct and indirect effects of soil management on aphids could lead to improvements in control of this insect pest on potato.

Aims and objectives

The project aims to investigate the effects of different soil management systems on potato aphid pest status and biocontrol by a parasitoid wasp when potato plants are grown in soil with different management history – integrated vs conventional. We will:

- Evaluate insect (potato aphid) performance when exposed to soils with different biological, chemical and physical properties due to differences in their management histories;
- Determine parasitoid behaviour when locating aphids feeding on potato plants grown in different soil treatments.

Research results

In May 2021 soil from the CSC based at Balruddery Farm was collected from the Middle East field, from either conventional or integrated field halves, and used for growing potatoes plants for the experiment. After 10 weeks of growth, aphids were inoculated onto plants and thereafter parasitoid choice tests were performed. Finally, the soil was collected for chemical/physical analysis as well as characterising the rhizosphere microbiota using ribosomal DNA sequencing methods.

Generally, the total number of aphid nymphs was higher on plants grown in conventional soil compared with the plants grown in integrated soil, and parasitoids preferred plants grown in integrated soil compared the conventional ones.

Using ribosomal 16S sequencing, 1826 taxa of bacteria were detected, which is likely to have captured most of the microbiome diversity (i.e. species richness) as shown by the plateau in the rarefaction curve (Figure 1). PERMANOVA analysis showed statistical differences in soil microbial community composition between the two soil treatments .

Outcomes

The study proposed here aimed to understand the role of soil microbial community in supressing potato aphid pests. The main outcomes were:

1. Clarification of the influence of native soil microbiota on aphid pests of *Solanum tuberosum*
2. Quantification of parasitoid success when exposed to aphids feeding on potato plants grown in different soil microbial communities.

The experiment was successful in establishing the soil treatments and aphid treatments. The results of this study showed, for the first time, that the soil microbial community can increase plant's attractiveness toward natural enemies and therefore their success. Furthermore, the soil microbial community reported different ASVs (amplicon sequence variants) between treatments. Taken together, these results indicated that soils with specific characteristics, including microbiome composition, could be effective in suppressing insect pests. Understanding the role of soil microbial community could contribute to improve and tailored Integrated Pest Management (IPM) strategies. Hence, farmers could benefit from beneficial microbes for controlling insect pests. Adopting tailored soil management practices could minimise their reliance on pesticides and improve biodiversity.

Next steps

The work presented in this project describes a preliminary investigation of multitrophic interactions, with results suggesting that soil management does influence parasitoid success. However, the mechanism by which soil management and the soil microbial community influence and/or trigger plant defenses, for example through changes in plant volatile emissions, is unknown.

To conclude, the findings of this project highlight two main areas for future investigation:

1. What is the effect of soil management on the third trophic level?
2. Can soil management modulate plant defense mechanisms that could promote ecosystem services?

Appendixes

Figure 1. Rarefaction curve showing the number of 'species' (bacterial taxa) characterised with increasing sample size in this study.