The role of endophytic entomopathogenic fungi on pest-host-parasitoid interactions: a chemical ecology perspective

Supervisory team:
Rothamsted supervisor: Dr Mike Birkett (Rothamsted Research)
Academic supervisor: Dr Andy Bailey (University of Bristol)
Dr Jozsef Vuts (Rothamsted Research), Dr Lucy Alford (University of Bristol), Dr John Caulfield (Rothamsted Research), Dr Gareth Thomas (Rothamsted Research)

Host institution: Rothamsted Research (Harpenden)
Submit applications to this project to University of Bristol

Project description: Herbivorous insects, including pests, can interact with plants, fungi and parasitoids in a web of ecological interactions. What are the chemical cues mediating these interactions, and how can they be used to develop effective pest management strategies? What are the implications of these pest management strategies on third trophic level, non-target beneficial insects?

You will test the following hypotheses using: entomopathogenic fungi, aphids (Myzus persicae) and aphid parasitic wasps (Aphidius spp.):

- Aphids/parasitoids differ in their olfactory preference towards plants inoculated with different endophytic entomopathogenic fungi
- Plants inoculated with different entomopathogenic fungi will produce unique volatile organic compound (VOC) profiles
- Antennae of aphids/parasitoids can detect these unique plant VOCs
- Aphids feeding on inoculated plant hosts will display reduced fitness (longevity, fecundity, nutritional status)
- Parasitoids emerging from aphid hosts reared on inoculated plants will display a reduced fitness (including longevity, fecundity, morphology, functional response, patch allocation, learning and memory retention, thermal physiology).

You will first determine whether aphids/parasitoids prefer plants inoculated with different entomopathogenic fungi, acquiring plant microbiology and insect behavioural skills. As VOCs are used by insects for host location, you will collect VOCs from plants using dynamic headspace collections and analytical chemistry methods (gas chromatography (GC), coupled GC-mass spectrometry) to quantify and identify VOCs. You will apply statistical analyses to these datasets to determine differences in plant VOC production following inoculation. You will learn electrophysiology (coupled GC-electroantennography) to determine which VOCs within a complex blend can be detected by aphid/parasitoid antennae, and generate synthetic blends of compounds to test whether these are behaviourally active. Finally, you will assess non-lethal impacts of fungi-inoculated plants on the third trophic level organism, the parasitoid wasp, and their role in biological control. This project aims to generate knowledge that will inform the development of pest management strategies, where entomopathogenic fungi are used to optimise aphid biocontrol by natural enemy parasitoids.

You will receive training in hypothesis formulation and testing, laboratory techniques, statistical analysis, experimental design, and the dissemination of scientific research to the academic community and the general public. The supervisory team at Rothamsted Research and the University of Bristol consists of experienced chemical ecologists, microbiologists, entomologists and analytical chemists that aim to deliver science with impact in agriculture. Through this studentship, you will have a unique chance to understand how multitrophic ecological interactions can be harnessed for better agricultural pest management solutions, supporting a regenerative agriculture approach to farming systems.

Our aim as the SWBio DTP is to support students from a range of backgrounds and circumstances. Where needed, we will work with you to take into consideration reasonable project adaptations (for example to support caring responsibilities, disabilities, other significant personal circumstances) as well as flexible working and part-time study requests, to enable greater access to a PhD. All our supervisors support us with this aim, so please feel comfortable in discussing further with the listed PhD project supervisor to see what is feasible.