FoodBioSystems DTP - PhD Project Advertisement

Project title:

FBS2021-61-Otten: Improving herbicide degradation studies: maintaining soil structure, microbial functioning and rhizosphere effects to reflect natural conditions.

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Project description:

Aim: This studentship offers an exciting opportunity to develop a deeper understanding of the role of soil structure, the rhizosphere and microbial diversity on herbicide degradation rates, and to apply this knowledge to the design of test systems for use in predicting optimal application and environmental impact. This aligns with a critical business driver for Syngenta to improve the quality of data and understanding of key drivers in Terrestrial Field Soil Dissipation studies.

Background: Food security is one of the major challenges facing populations today. The reduction in land available for agriculture and increasing populations are resulting in a growing demand for higher yields from agricultural land than ever before. A component of this is a continuing need for modern, safe agrochemicals available to reduce losses due to weeds, pests and diseases. This requires the best possible understanding of their behaviour and degradation in agricultural ecosystems. The field and laboratory testing under the current regulatory framework fall short on delivering this understanding as they are conducted under controlled conditions that deviate from natural field conditions. There are significant limitations to current test guidelines (OECD 307) for evaluation of the transformation of potential crop protection chemicals. Firstly, OECD 307 specifies that soil should be sieved (<2 mm) prior to incubation studies; the resulting disintegration of structure influences the size, activity and composition of microbial communities through a number of mechanisms: (i) dehydration of cells previously inside water-filled aggregates but now exposed to air; (ii) rupture of macroaggregate-

binding fungal hyphae; (iii) altered bioavailability of microbial substrates, e.g. soil organic carbon previously occluded within aggregates; and (iv) spatial reorganisation of microbial populations and the altered connectedness of water- and air-filled pathways. A second significant shortcoming is the absence of crops. Recent work by Syngenta using a 14C labelled herbicide (prometryn) showed that inclusion of viable crop root systems resulted in faster decline of the herbicide (50% of DT50), higher formation of non-extractable residues, and minimal uptake by the plants (Hand et al., 2019). There is a significant knowledge gap in the relative magnitude and interaction of these different processes, and a need to incorporate more realistic scenarios into herbicide dissipation studies.

This study will characterise the biological and structural complexity in an agricultural soil, and develop an understanding of what is lost from the soils in current testing systems. The study will also identify how shifts in agronomic practices, such as the inclusion of more cover crops or shifts to reduced-till systems, affect pathways of degradation in order to enhance predictability of CPP fate based on innovative test systems.

Specifically, the study will address the following objectives
Objective 1. Quantify key physical and biological pathways and drivers of transformation of Crop Protection Products (CPP) in test systems and fields. Experiments will examine the effect of soil physical disturbance, soil type, and CPP chemistry on CPP biotransformation and the soil microbial (community size, composition, activity), biochemical (e.g. available carbon co-substrates) and biophysical characteristics (e.g. connected air and water ways; diffusion).

Objective 2. Develop methods which maintain or recreate key soil physical properties that retain functional diversity in soil microbial communities, so that degradation rates more closely reflect field measurements.

Objective 3. to quantify the relative importance of the biophysical (soil structure), biochemical (rhizodeposition) and microbial (rhizosphere) effects on microbial communities brought about by the processes in the rhizosphere that contribute to driving differing CPP behaviour in planted versus non-planted soil.

This work advances our understanding to improve the link between laboratory test systems and predictive models of environmental fate to obtain better estimates and identify factors that drive worst case scenarios for persistence in the environment. This is critical for the development of new products designed for crop protection.

Training opportunities:

This studentship benefits from close collaboration with industrial partner Syngenta. Training includes an invitation to their annual research collaborations conference, and benefit from a 3-month placement. Students also receive additional supervision and access to equipment and other Syngenta resources such as the 14C laboratory.

You will work with leading academics and facilities at both Cranfield University and the University of Reading. Specific training in soil science and microbiology includes: Training at soil physical techniques

and processes across scales from micro-meters in the rhizosphere to field scale measurements including soil structure (traditional methods and X-ray CT), water availability, water infiltration/hydraulic properties, diffusion processes, soil structure-microbe interactions, design of lysimeter studies, and bespoke one-to-one training in soil microbiology and biochemistry methods, including: nucleic acid extraction from soil for subsequent sequencing of 16S rDNA and ITS amplicons using high throughput technologies (e.g. Illumina MiSeq); bioinformatic and statistical analysis of sequencing outputs; analysis of concentration and quality of available soil carbon (physical and chemical fractionation methods, UV- and fluorescence spectroscopy, NMR spectroscopy); assays for soil microbial activity.

In addition, you will benefit from the Cranfield Doctoral Researchers Core Development (DRCD) programme which is based on the national Vitae researcher development framework. Training is tailored to individuals and includes research and writing skills, communication skills and public engagement, ethics and risk management, business and leadership skills.

Student profile:
We are looking for an enthusiastic graduate of environmental, biological or chemical sciences, with an interest in in soil microbial processes and environmental risks. Completion of a MSc in a relevant field, experience of soil microbiology and knowledge of UK agricultural practice will be an advantage. The project will develop skills towards experimental design and implementation, laboratory skills and statistical analysis. You should be keen to communicate their scientific findings to academia and industry.

Funding particulars:
This CASE studentship is co-funded by Syngenta. The project is part of the FoodBioSystems BBSRC Doctoral Training Partnership (DTP), it will be funded subject to a competition to identify the strongest applicants.
The studentship is open to UK and international students (including EU countries) however due to funding rules, no more than 30% of the projects can be allocated to international students.
The funding will include a tax free stipend (minimum £15, 285 per year), support for tuition fees at the standard UK rate (currently £4,407 per year) and a contribution towards research costs. **Please note** that the host universities have not yet confirmed the level of fees charged to international students funded by the DTP. Fee levels may vary across the institutions. This information will be shared on the FoodBioSystems DTP website as soon as it becomes available.

To apply
Please go to FoodBioSystems DTP website for information on how to apply for this studentship. The closing date for applications will be 8 February 2021.