Project Title: FOODBIOSYSTEMS - Development of different natural biopesticide formulations of plant extracts for control of economically important cereal and grass diseases

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Research Group: FOODBIOSYSTEMS BBSRC DTP
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Project Description: In todays' cropping systems, crop protection chemicals are used extensively to maintain crop productivity and reduce pest/disease damage. In recent years, farmers have seen a significant increase in the build-up of resistance in fungal pathogens and pests to synthetic chemicals, especially in economically important export crops, including cereals and fruits. Fungal pathogens evolve quickly and some pathogen genotypes are able to survive fungicide concentrations that normally kill or inhibit the development of sensitive genotypes of the same species. In addition, because of human health and environmental impacts, there is a drive for the use of alternative natural compounds. The EU has banned 50% of crop protection chemical groups because of such environmental and health concerns. There is interest in alternative compounds that can control economically important pathogens especially in cereals and grasses for fodder. This has led to an increased interest in biological pesticides, based on naturally occurring substances, which may control diseases or pests. Recent studies by AlphaBio and Apreslabs have suggested that formulations of lipid-based plant extracts have potential for control of some cereal diseases. These have benefits of being less toxic, pose fewer health and environmental risks. There is particular interest in better control of economically important *Fusarium* pathogens of cereals (wheat, oats, feed maize) and *Drechslera* diseases (forage grasses). The former group also contaminates cereals with mycotoxins.

Aim: to examine the effect of different formulations of these biopesticides for control of foliar *Fusarium* diseases of cereals and *Drechslera* species in fodder grasses and reduction in mycotoxin production, identification of their mechanism of action and their cost-benefit analyses. We will utilise the "Bioscreen C" rapid assay system (Medina et al., 2012) to evaluate formulations for (i) control of spore germination and colonisation rates, (ii) impacts on secondary metabolite production and (iii) ecological resilience (see Carbo et al., 2018; 2019).

Objectives: (a) rapid screening (Bioscreen C) system to identify the efficacy of different formulations of the natural products for control of germination/growth of *Fusarium* (*F. graminearum, F. langsethiae, F. asiaticum, F. verticillioides*) and *Drechslera* species; (b) identification of the best formulations by

quantifying using a modelling approach the ED50 and MIC concentrations and make comparisons with existing fungicides; (c) examine the mechanisms of action of the best formulations by vital staining and permeability assays using fluorescence microscopy and flow cytometry; (d) quantify relative effects on control of mycotoxin production by impacts on expression of key biosynthetic genes involved in toxin production using RT-qPCR (*TRI*, *FUM* genes) and on phenotypic toxin production; (e) testing of the best formulations and concentrations for control of *Fusarium* in ripening wheat ears and maize cobs, and of *Drechslera* in seedlings of forage grasses and comparisons with existing fungicides; (f) With the industrial partner examine the cost-benefit analyses for incorporation of such natural compounds into the crop protection system for disease control in cereals/grasses. Some of these also offer protection against cereal pests. This project will have benefits for sustainable and organic cereal and forage grass sectors, and improve pre-harvest management of economically important food/feed crops destined for human and animal feed chains.
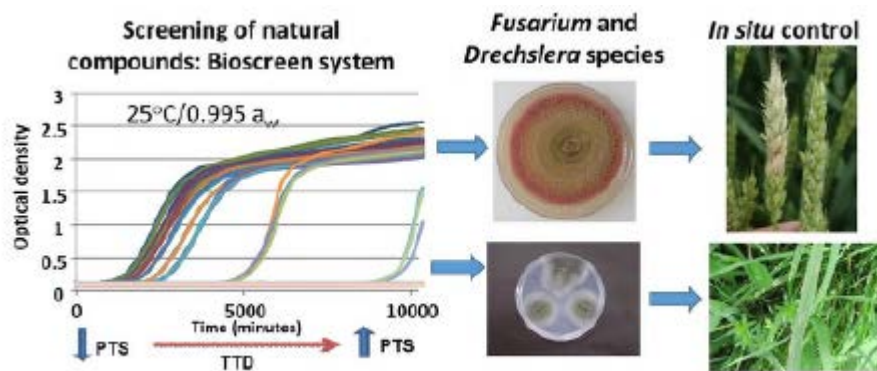
Funding Notes: This project is part of the FoodBioSystems BBSRC Doctoral Training Partnership (DTP), it will be funded subject to a competition to identify the strongest applicants. Due to restrictions on the funding, this studentship is only open to UK students and EU students who have lived in the UK for the past three years.

This project is a CASE award linked to AlphaLabs (Cambridge) and Apreslabs (Rothamsted Innovation Hub) who will provide additional stipend (£2000) and a contribution to consumables. Funding will be provided for time-periods spent with partners.

The FoodBioSystems DTP is a collaboration between the University of Reading, Cranfield University, Queen's University Belfast, Aberystwyth University, Surrey University and Brunel University London. Our vision is to develop the next generation of highly skilled UK Agri-Food bioscientists with expertise spanning the entire food value chain. We have over 60 Associate and Affiliate partners. To find out more about us and the training programme we offer all our postgraduate researchers please visit https://research.reading.ac.uk/foodbiosystems/.

Training opportunities: The student will receive a range of specific opportunities. At Cranfield, the Applied Mycology Group is a vibrant research activity, that has expertise in fungal ecology, ecophysiology and molecular ecology as well as predictive modelling skills that will help the student in significantly enhancing their fundamental and applied research expertise. The student will also be able to attend MSc course modules in our Food Chain and Management and Future Food Sustainability courses that will assist in providing excellent background knowledge on raw material quality assurance, certification, food mycology, molecular plant

pathology and ecology, diagnostics and the food security agenda. In addition, Cranfield provides generic PhD student training in project and time management, scientific writing skills, statistics and data management, and presentation skills. In addition, periods of time will be spent with the co-supervisors at Aberystwyth University and with the industrial collaborators in AlphaLabs (Cambridge) and their partners at Rothamsted Innovation Hub (Apreslabs). This will provide additional experience which will be beneficial for employment opportunities in relevant crop protection industries.

Student profile: The candidates must have a biological sciences related degree and possibly an MSc in a relevant area, e.g. Agricultural Sciences, Plant Pathology, Crop Protection or Molecular Diagnostics. Needs to have some interest and background in microbiology/mycology and molecular biology, or have some experience in biochemistry so that analyses for mycotoxins can be effectively done. Some interest in interacting with the commercial side of agriculture, especially in relation to the crop protection industry, would be beneficial.

References:
Carbó, A. et al. (2018a). Impact of climate change environmental conditions on the resilience of different formulations of the biocontrol agent *Candida sake* CPA-1 on grapes. *Letts. Applied Microbiol. 2-8.* **doi:10.1111/lam.12889**
Carbó, A. et al. (2019). Ecological niches and environmental resilience of different formulations of the biocontrol agent *Candida sake* CPA-1 using the Bioscreen C. *Biocontrol 63, 855-866.*
Medina, A. et al. (2012). Rapid throughput analysis of filamentous fungal growth using turbidimetric measurements with the Bioscreen C: A tool for screening antifungal compounds. *Fungal Biol. 116, 61-169.*