FoodBioSystems DTP - PhD Project Advertisement Text

Project Title: FOODBIOSYSTEMS - Temperature regulation of microRNAs and crop - rhizosphere interactions

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Project Description: Plants manipulate the rhizosphere (soil surrounding the plant root) through the release of water-soluble and volatile organic compounds known collectively as root exudate. Root exudate can recruit beneficial soil microflora and fauna; however, it can also attract parasites and pathogens, with implications for plant health and yield. Our preliminary data demonstrate that temperature alters tomato root exudate composition, which affects the hatching and attraction of economically important plant parasites and microbes. Understanding the impact of temperature on important plant-rhizosphere interactions will help to develop climate-smart approaches to crop protection, driving the sustainable intensification of agriculture.

We have generated transcriptomic datasets from developmentally-matched tomato seedlings grown independently at 18, 23 and 28 degrees C. Our data indicate that non-coding microRNAs and predicted target genes are differentially expressed as a factor of temperature. MicroRNAs regulate the expression of target genes in a sequence-dependent manner, modulating diverse aspects of plant physiology and function. Individual microRNAs have the potential to regulate hundreds of transcripts simultaneously. On that basis, microRNAs and/or microRNA target sites on targeted genes, represent an attractive focal point for breeding / biotechnology and novel crop improvement strategies. Our data identify a range of target genes that demonstrate asymmetric differential expression relative to their cognate microRNA, belong to a wide range of families, including ATP-Binding Cassette (ABC) transporters, Multidrug And Toxic compound Extrusion (MATE) transporters, Ethylene Response Factors (ERFs), UDP-glycosyltransferases, and sugar transporters, which have all been linked to the control of root exudate composition previously. We hypothesise that these microRNAs and target genes contribute to the modification of root exudate composition and altered interactions with parasites and microbes as a factor of temperature.

The goal of this project is to link selected temperature-regulated microRNAs and target genes to specific changes in root exudate composition, and altered plant-rhizosphere interactions. We will address this goal by confirming microRNA-mRNA interactions (transcriptomics and degradome sequencing) and investigating microRNA and target gene functions (transgenic over-expression / microRNA decoys / RNA interference). We will then assess parasite / microbe behaviours for a range of organisms, including *Globodera pallida, Meloidogyne incognita, Bacillus subtilis, Pseudomonas aeruginosa, Agrobacterium tumefaciens, Funneliformis* and *Rhizophagus* species (hatching / attraction / invasion / biofilm formation / *Vir* gene induction / spore germination / hyphal branching etc. as appropriate to individual species). We will also assess exudate compositional change using metabolomics (LC-Qtof-MS and GC-MS).

A core driver for this proposal is our recently discovered ability to alter the behaviour of selected plant pathogens and microbes within the rhizosphere by manipulating plant root exudate composition using temperature. This finding provides a new opportunity to: (i) dissect exudate-pathogen interplay to optimise the selection of beneficial (pathogen inhibiting) exudate components; (ii) identify the mechanisms driving beneficial plant root exudate changes. This project will link individual temperature-regulated microRNAs and target genes to specific changes in root exudate chemistry, and altered plant-rhizosphere interactions. These microRNAs and target genes could be exploited for crop improvement through breeding, genome editing or biotechnology. Likewise, an understanding of the exudate compounds that influence organismal behaviour in the rhizosphere would be valuable, and could lead to new methods of rhizosphere engineering.

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.

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: Technical training will include: transcriptomics and bioinformatics; core molecular techniques (including DNA / RNA extraction, qRT-PCR etc.); plasmid design and construction; plant transgenesis; reverse genetics; parasite and microbe behavioural assays / AMF interaction assays will be taught in conjunction with collaborators in the Pelligrino lab (Scuola Superiore Sant'Anna [SSSA; Pisa, Italy]); metabolomics and data analysis; training in communication with the general public, including children through workshops/school visits. Attendance of diverse national and international conferences will provide further opportunities to develop presentation skills and network with peers.

QUB offers a wide range of training courses in conjunction with the Graduate School, and the 'Postgraduate Development Programme'. Likewise, The University of Reading offers the 'Reading Researcher Development Programme'. Collectively, these programmes offer a broad range of relevant skills and training opportunities for the student.

There will also be opportunities to collaborate with international partners in Kenya / Ghana, to explore opportunities to translate project outcomes into the sub-Saharan Africa context.

Student profile: This project would suit a student with a degree in biological science / microbiology / plant biology, who has a keen interest in plant interactions. The successful student should be willing to learn a wide variety of technical skills and apply a creative mind-set to this challenging project. Previous experience in plant sciences, molecular biology, bioinformatics, nematology, microbiology would be beneficial, but not strictly required.