

Fusarium disease of wheat – exploring tissue specific host-pathogen interactions using a systems biology approach

Supervisory team:

Rothamsted supervisor: Dr Martin Urban (Rothamsted Research)

Academic supervisor: Dr Neil Brown (University of Bath)

Prof Kim Hammond-Kosack (Rothamsted Research), Dr Samuel Sheppard (University of Exeter), Dr Smita Kurup (Rothamsted Research), Dr Ryan Ames (University of Exeter)

Host institution: Rothamsted Research (Harpenden)

Project description:

Ensuring global food security for the ever-growing world's population is a major concern. Fungal pathogens destroy a substantial amount of all food crops each year (~15%). Particularly serious are Fusarium ear blight disease of wheat caused by cereal infecting Fusaria fungi (www.scabusa.org). These fungi produce secondary metabolites that include various harmful toxins that allow the pathogens to overcome the host's innate defence system and cause disease.

The main scientific aims of this project are (A) to define the interactions between a pathogen and its host by evaluating transcriptional alterations during infection across multiple scales of resolution, from whole tissues to individual cell-types using laser capture microdissection (B) to use a computational network analyses approach to identify key pathogen virulence and host resistance/susceptibility genes (C) to test the function of the identified genes by creating fungal gene deletion mutants and by altering wheat gene expression using virus induced gene silencing. The student will therefore gain knowledge of crop protection and pathogenomics, in addition to invaluable training in molecular genetics (fungal and plant), transcriptomics, microscopy and computational biology. This will provide them with excellent transferable skills for careers in biosciences.

Selected references: Ames - doi 10.3390/microorganisms5010003; Brown et al. - doi 10.1111/mpp.12564; Urban et al. - doi 10.1046/j.1364-3703.2003.00183.x; Lee et al. - doi 10.1104/pp.112.203489.

Rotation project one: The student will learn how to delete genes in the fungal pathogen *Fusarium graminearum* using already available virulence gene candidates under the supervision of Dr Neil Brown at the University of Bath. The leads were obtained using predicted protein-protein interaction computational network analysis of siRNA targets. Gene deletion constructs will be generated by PCR and transformed into fungal protoplasts. Mutants will be selected and phenotypically characterised. This project will expose the student to PCR, primer design, laboratory and microbiological techniques. Initial training on bioinformatics data analyses pipelines will be given by Dr Ryan Ames, University of Exeter via formal meetings, workshops available at the University of Exeter and by Skype.

Rotation project two: The student will grow and infect wheat plants with *Fusarium graminearum*. RNA from the host-pathogen interaction will be prepared during several infection timepoints. The student will be introduced into wheat anatomy, tissue microdissection and light and laser capture microscopy. This project will expose the student to plant controlled environment conditions operating at biological safety Category level 2. The RNA prepared will help to inform the experimental design of similar experiments during the main PhD project. Already available RNAseq data from *Fusarium* infected wheat will be analysed using various bioinformatics tools. The project will take place at Rothamsted Research supervised by Dr Martin Urban, Dr Smita Kurup and Prof Kim Hammond-kosack.

