PhD Project Advertisement

Project title: Deciphering spatial colonisation and pathogenesis of *Fusarium oxysporum* f. sp. cepae on onions by assessing associated physical and biochemical changes to decrease food loss

Project No: FBS2024-048-Landahl-cr

Lead supervisor: Sandra Landahl, Soils, Agrifood and Biosciences, Plant Science Laboratory, Cranfield University

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Co-supervisors:

Luke Bell, University of Reading

Carol Verheecke-Vaessen, Cranfield University

Dr Gianfelice Cinque, Diamond Light Source

Lembe Magwaza, Cranfield University

Student profile:

We are looking for applicants with:

- A background and/or experience in biophysics or biochemistry is desirable, but not mandatory.
- Experience with machine vision or imaging, microscopy or spectroscopy is desirable.
- Skills in either plant biomechanics or microbiology would be appropriate for this project, although training will be made available according to the student's needs.
- An interest in the agrifood sector with the right focus on new bioimaging methodologies would also be an asset.

Please note:

- This four-year studentship is available only to individuals who are eligible for UK/home student fees status. We regret that we can not fund international students on this occasion, and we will not process applications from any candidates who require a visa to study in the UK.
- The studentship start date is flexible up until 1 December 2024 but for operational reasons can not start after this date.

Project description:

How do the host onion plant and pathogenic fungus (*Fusarium*) interact at different stages of development?

The resilience of the onion plant to *Fusarium* is critically related to specific stages in its development. Advanced imaging of the *Fusarium*–onion interaction at different wavelengths – X-ray, visible and infrared (IR) – from growth through to the postharvest period, combined with an analysis of the onion's nutrients will elucidate the process of virulence. In the proposed study, the biochemical responses of the plant at each developmental stage will be correlated with those of the fungus.

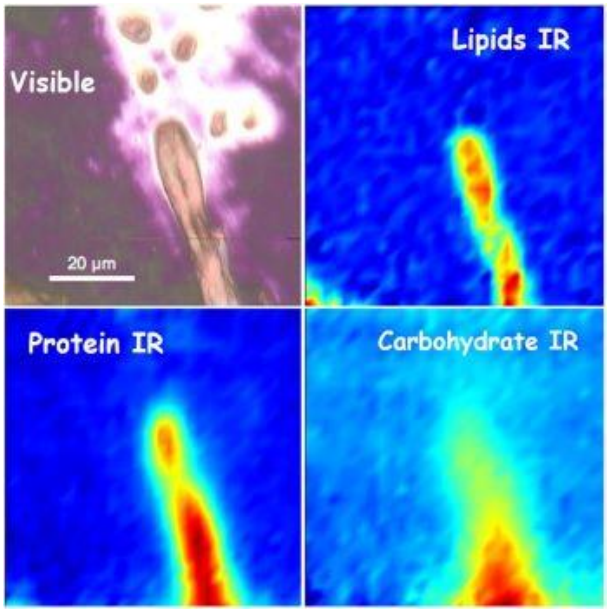
Key Objectives:

The aim of this project is to decipher the spatial colonisation and pathogenesis of *F. oxysporum* f. sp. *cepae* on onions by assessing the physical and biochemical changes that take place during bulb growth in response to the disease. This knowledge is essential for early disease detection, crop health assessment and the establishment of effective crop-storage management strategies to reduce food losses and minimise further disease spread in onion production.

Cutting-Edge Research Methods

A series of state-of-the-art imaging techniques will be examined and evaluated in order to study the interaction between *Fusarium* and onions.

Optical coherence tomography (OCT) is a non-contact, real-time technique suitable for assessing the near-surface internal structure of plant tissue. It has been used to visualise the shape and size of plant cells at different tissue boundaries. Collaborative relationships with the photonics group at Cranfield University provide access to a commercial OCT system.



X-ray computed tomography scanning, which affords a convenient means of non-destructively recording the external and internal structures of seeds and fruits, offers the potential to compile data on their three-dimensional characteristics and internal morphologies.

At DLS, molecular microanalysis via Fourier Transform IR (FTIR) micro-spectroscopy using either synchrotron radiation in quasi confocal mode (to enable the highest spatial resolution at the sub-cellular scale) or focal plane array imaging in full field mode (for a broad field of view) are both envisaged for fresh/live bio-sample analysis. FTIR nano-spectroscopy may be considered at the 100-nm level for a subcellular analysis of the pathogen.

At University of Reading, the student will have the opportunity to acquire advanced volatile organic compound collection and analysis techniques. Samples will be analysed using two-dimensional gas chromatography mass spectrometry, a powerful technique for identifying molecular markers of infection and understanding the biological processes underlying plant infection and immune response.

At Cranfield University there will be access to glasshouses and the institution's Environmental Analytical Facility.

Professional collaboration and training opportunities

The student will have access to multi-disciplinary learning and research along with the expertise of professional working groups at the collaborating universities and Diamond Light Source (DLS) in the fields of plant husbandry, imaging, mycology, mass spectrometry and structural biology for an integrated approach.

At Cranfield University, the student will be a member of two groups:

1. The Plant Science Laboratory, with expertise in plant ecophysiology, postharvest technology, non-destructive testing, biochemistry and plant biomechanics.
2. The Applied Mycology Group, with expertise in fungal ecology, ecophysiology, analytical chemistry and molecular biology.

At DLS, the student will be a member of the IR beamline group where:

1. The Multimode InfraRed Imaging and Microspectroscopy beamline, B22, a leading research method for hyperspectral bioimaging at the cellular and subcellular scales, can be learned and applied.
2. Chemometrics training will be available for hyperspectral imaging and vibrational micro/nano-spectroscopy.

At University of Reading, the student will learn and apply the following:

1. Two-dimensional gas chromatography time-of-flight mass spectrometry as an advanced approach for untargeted analysis of volatile organic compounds (VOCs) in foodstuffs.
2. Temporal monitoring of VOC emissions from bulbs during storage as well as consumer-focused traits related to flavour. University of Reading has an established track record in the analysis of food composition and flavour and has recently expanded its mass spectrometry and other analytical techniques' capability.

In addition to completing training delivered by the FoodBioSystems DTP , the student will be able to attend MSc course modules at Cranfield University in: applied bioinformatics, food systems and management, and future food sustainability courses, providing excellent background knowledge on data analysis, programming, food diagnostics, food mycology and the food security agenda. The student will also attend training from Cranfield University's Doctoral Researchers' Core Development programme in topics such as project and time management, scientific writing skills, statistics and data management, and presentation skills.
At DLS, there will be world-leading training in IR microscopy and imaging with comprehensive data analysis, utilising machine-learning classification tools for hyperspectral imaging. The student will develop expertise in high resolution imaging and microanalysis, including sample preparation.

The student will additionally undertake placements at an onion growers' association, to familiarise themselves with relevant industrial standards and practices, and University of Reading

Stipend (Salary):

FoodBioSystems DTP students receive an annual tax free stipend (salary) that is paid in instalments throughout the year. For 2024/25 this is £19,237 (increased slightly each year at rate set by UKRI). Diamond Light Source Ltd co-funds the project and the studentship attracts a £2,000 pa stipend top-up.

Equality Diversity and Inclusion:

The FoodBioSystems DTP is committed to equality, diversity and inclusion (EDI), to building a doctoral researcher(DR) and staff body that reflects the diversity of society, and to encourage applications from under-represented and disadvantaged groups. Our actions to promote diversity and inclusion are detailed on the FoodBioSystems DTP website.

In accordance with UKRI guidelines, our studentships are offered on a part time basis in addition to full time registration. The minimum registration is 50% FT and the studentship end date will be extended to reflect the part-time registration.

For up to date information on funding eligibility, studentship rates and part time registration, please visit the FoodBioSystems website.