PhD Project Advertisement

Project title: Advanced gene editing to improve water use efficiency in crops
Project No: FBS2024-009-Thompson-ca

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Project description:

The availability of water for agriculture is in decline because of population growth and due to changing rainfall patterns under climate change. Food production must increase, but water is being abstracted from rivers and ground waters faster than it is being replenished. A sustainable way to address this problem is by breeding crops with improved water use efficiency (WUE). We have already achieved this in tomato by creating plants with higher levels of the plant hormone abscisic acid (ABA), achieve by using GMO technology to increase the expression of the enzyme that drives the synthesis of ABA. But translating this success into practice is challenging because: i) there are barriers to commercialisation of GM plants; and ii) it is difficult to get the optimum amount of ABA produced in the right place at the right time during plant development. In this project it is timely to make use of an alternative technology, gene editing, to achieve high WUE crops; this will make it much easier to deliver the outcome into the real world because the UK's Genetic Technology (Precision Breeding) Act 2023, and similar regulatory frameworks around the world, are now being implemented. Success in this project could drastically reduce the amount of water we need to produce our food, making our food supply chains more secure, and preventing loss of biodiversity in rivers and wetland habitats.

First, at Cranfield University, you will use bioinformatics methods to survey DNA sequences of hundreds of versions of the same target gene in tomato and its wild relatives to establish what genetic variation exists and how this compares to our knowledge about the function of different parts of the gene. You will then devise the gene editing strategy most likely to increase gene expression, and then implement the strategy to create plants carrying novel genetic variation. You will then screen the plants for improvements in gene expression, ABA levels, growth rates and water use before undertaking more detailed analysis on selected plants at the University of Aberystwyth's National Plant Phenomics Centre where data on water use and plant growth can be captured at many time points using the latest automated imaging and sensor technologies. There will also be an opportunity to test a novel hypothesis about how the target gene is so rapidly regulated under water stress – this will increase our fundamental understanding of gene regulation and open new opportunities to engineer more sustainable crops.

Training opportunities:

You will develop an understanding of crop biotechnology, especially the most recent developments in gene editing and how this can be applied in plant breeding and will become expert in how to improve water use efficiency through crop improvement. You will be trained in bioinformatics, molecular biology, plant tissue culture and physiological methods to assess photosynthesis and water use in whole plants, along with statistical methods for experimental design and statistical analysis. You will be trained in data capture in the Aberystwyth phenotyping facilities and in image analysis methods to extract information from the data. Training will include formal one week modules on specific topics, and 1-2-1 coaching. You will attend one or more conferences about Precision Breeding, phenotyping and/or multidisciplinary events about drought and crop water use.

Student profile:

You must be highly inquisitive and enjoy carrying out research into new topics. You will be familiar with the concepts of genetics and molecular biology from your academic studies and will have some experience of practical experimental work in a laboratory environment. You will be numerate and have the aptitude for data analysis, e.g. through the use of software platforms or through coding in R, although full training will be provided.

Stipend (Salary):

FoodBioSystems DTP students receive an annual tax free stipend (salary) that is paid in instalments throughout the year. For 2023/24 this is £18,622 and it will increase slightly each year at rate set by UKRI.

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.

References:

Vadez et al (2023) Water use efficiency across scales: from genes to landscapes, Journal of Experimental Botany, 74:4770–4788, https://doi.org/10.1093/jxb/erad052

Thompson et al (2007) Overproduction of abscisic acid in tomato increases transpiration efficiency and root hydraulic conductivity in influences leaf expansion. Plant Physiology, 143: 1905–1917, https://doi.org/10.1104/pp.106.093559

Knott and Doudna (2018) CRISPR-Cas guides the future of genetic engineering. Science 361:866-869. https://doi.org/10.1126/science.aat5011

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