FoodBioSystems DTP - PhD Project Advertisement Template

Project title:

FBS2021-57-Bosch: Growing in the wind: The impact of mechanical stimulation on wheat

Lead supervisor:
Maurice Bosch, Aberystwyth University, IBERS

Email:

mub@aber.ac.uk

Co-supervisors:
Paola Tosi, University of Reading, School of Agriculture, Policy and Development
Seyed Ghaffar, Brunel University, Department of Civil & Environmental Engineering
John Doonan, Aberystwyth University, IBERS & National Plant Phenomics Centre

Project description:
Wheat is the most widely cultivated cereal in the world and one of the most important food crops. Since wheat is central to our food production, understanding its responses to different environmental conditions is of major importance. Mechanical stimulation, including exposure to wind, is a common environmental variable for plants. However, knowledge about the morphogenetic response of wheat to mechanical stimulation and impact on relevant agronomic traits is limited.

We have recently shown that mechanical stimulation in the model grass *Brachypodium distachyon* induced significant quantitative changes across multiple scales, from the whole plant down to cellular level. Mechanical stimulation resulted in shorter stems, reduced biomass, increased tissue rigidity, delayed flowering, and reduced seed yield [1]. Mechanical stimulation also led to changes in cell wall properties and reduced enzymatic sugar release [1]. Recent data on mechanical stimulation in wheat, using brushing, revealed a remarkable age and dose-response to mechanical stimulation. Besides affecting plant phenological traits, the treatment of two-week old wheat plants significantly affected grain development.

These findings highlight that exposure of grasses to mechanical stimulation is a relevant environmental factor affecting multiple traits important for their utilization in food, feed, and bioenergy applications. Further studies are required to characterize the implications of mechanical stimulation and to identify and dissect the molecular mechanisms involved in the perception and transduction of mechanical stimuli that lead to the observed morphogenetic responses.

AIM AND OBJECTIVES

The student will utilize the biodiversity available for wheat to determine the effect of mechanical

stimulation on grain related traits as well as the consequences for the utilization of straw agricultural residues for biorefining applications. Available genetic diversity populations will provide a powerful platform to evaluate relevant genotypic diversity in the responses of wheat to mechanical stimulation and to identify genetic components involved in thigmomorphogenesis.

METHODOLOGY

1. The student will establish the impact of mechanical stimulation on wheat growth and development. In collaboration with the National Plant Phenomics Centre (https://www.plant-phenomics.ac.uk/) wheat plants will be exposed to a controlled mechanical treatment. In addition to traditional trait measurements, we will utilize µCT scanning to analyse the impact of mechanical stimulation on a range of morphological characteristics in stem and grain [2,3].

2. The student will determine the impact of mechanical stimulation on grain quality. Previous data has shown that mechanical stimulation negatively affects grain size and number. The interaction between genotypes and mechanical stimulation on grain quality measures as well as on processability parameters will be evaluated.

3. The student will evaluate the impact of mechanical stimulation on the utilization of wheat straw for biorefining purposes. The student will perform physico-chemical analysis of wheat straw after mechanical treatments to determine the impact on traits relevant for the downstream utilization of wheat straw in biorefining.

Figure 1. µCT images of main tiller spikes from wheat. Left, untreated control. Right, mechanical treatment for 2-weeks.

IMPACT

The utilization of a diverse set of wheat varieties will allow the student to start evaluating the genetic variation in growth and development responses to mechanical stimulation and how this could improve food production. This is even more important as simulations predict an increase in surface winds over the United Kingdom. Detailed analysis on the effect of mechanical stimulation on grain development and nutritional and processing quality, may inform on the selection of wheat genotypes to improve grain yield and quality under increasingly windy conditions. Analysis of the impact and genetic variation of mechanical stress on physico-chemical properties of wheat stems can improve the resistance of wheat to lodging, which is a key trait for crop improvement. In addition, such detailed analysis will improve the utilization and valorisation of wheat straw agricultural residue in a biorefinery.

SUPERVISORY TEAM

The student will be supervised by a multidisciplinary team with all the expertise to achieve the goals set out for this DTP studentship. The lead supervisor is Maurice Bosch (IBERS, Aberystwyth University), a molecular cell biologist with expertise in studying the interaction between cell wall properties and environmental conditions. The project will be co-supervised by Dr Paola Tosi (University of Reading) with expertise in cereal chemistry and grain processing quality, Dr Seyed Ghaffar (Brunel University) with expertise in physico-chemical measurements of wheat straw, and Prof John Doonan (Aberystwyth Universtity), director of the National Plant Phenomics Centre.

Training opportunities:

The student will have the opportunity to spend a couple weeks during the PhD at Reading and Brunel University to receive training in grain quality and physico-chemical measurements, respectively.

Student profile:

We are looking for a student that shows a keen interest in pursuing this multidisciplinary PhD project that will provide the candidate with training and skills in a range of varied techniques. This project would be suitable for students with a degree in biology, chemistry, agriculture, food science or a closely related subject.

Funding Note

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.
The studentship is open to UK and international students (including EU countries) however due to funding rules, no more than 30% of the projects can be allocated to international students.
The funding will include a tax free stipend (minimum £15, 285 per year), support for tuition fees at the standard UK rate (currently £4,407 per year) and a contribution towards research costs. **Please note** that the host universities have not yet confirmed the level of fees charged to international students funded by the DTP. Fee levels may vary across the institutions. This information will be shared on the FoodBioSystems DTP website as soon as it becomes available.

To apply

Please go to FoodBioSystems DTP website for information on how to apply for this studentship. The closing date for applications will be 8 February 2021.

References:

[1] Gladala-Kostarz, Doonan, Bosch (2020). Mechanical stimulation in Brachypodium distachyon: implications for fitness, productivity and cell wall properties. Plant Cell & Environment 43: 1314-1330.

[2] Hughes, Askew, Scotson, Williams, Sauze, Corke, Doonan, Nibau (2017). Non-destructive, high-content analysis of wheat grain traits using X-ray micro computed tomography. Plant methods 13: 76.

[3] da Costa RMF, Pattathil S, Avci U, Winters A, Hahn MG, Bosch M (2019). Desirable plant cell wall traits for higher-quality miscanthus lignocellulosic biomass. Biotechnology for Biofuels 12: 85.