PhD Project Advertisement

Project No/title: FBS2026 24 Gaju la / *Can roots plasticity improve nitrogen use efficiency (NUE) in wheat lines with biological nitrification inhibitors (BNI) properties?*

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Co-supervisors:

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Project Details

Nitrogen is a critical nutrient for crop productivity, yet its inefficient use in agriculture contributes significantly to environmental processes, including nitrate leaching and greenhouse gas emissions. Wheat is a major consumer of nitrogen fertilisers, and improving its nitrogen-use efficiency (NUE) is a key target for sustainable intensification.

Recent advances have identified biological nitrification inhibition (BNI) as a promising trait for reducing nitrogen losses due to roots ability to release compounds that suppress soil nitrifying bacteria, thereby slowing the conversion of ammonium to nitrate. The BNI trait has been successfully introgressed into wheat from a related wild grass Leymus racemosus by CIMMYT and JIRCAS, resulting in a set of elite BNI wheat line. However, the developmental and physiological consequences of BNI activity on above ground canopy and root systems remain poorly understood. It is hypothesised that BNI activity may influence root development, particularly under varying nitrogen regimes.

Research aims: The research aims at addressing the urgent need to reduce nitrogen fertiliser use in UK farming. How does the presence of the Biological Nitrification Inhibition (BNI) trait in wheat influence root architecture and function under varying nitrogen regimes, and what are the implications for nitrogen-use efficiency and crop resilience?

What you will do: During the course of the studentship the student will undertake field work for two years to collect data on wheat lines with BNI properties at key growth stages during the growing seasons at Riseholme campus University of Lincoln under varying nitrogen regimes. The data captured will consist mostly of above ground traits. The student will characterise root architectural and anatomical traits due to the BNI introgression using the unique designs of NPPC rhizotrons at IBERS (Aberystwyth) to allow semi continuous monitoring of root growth, direct manipulation of the roots/microbiome interaction. The student will take measurement of different functional zones, exudates and the spatial distribution of the root/rhizosphere microbiome. The data collected from the field and rhizotron will then be used to build a model that can identify traits associated with nitrogen use efficiency.

References:

1. G. V. Subbarao, et al. (2007). Can biological nitrification inhibition (BNI) genes from perennial Leymus racemosus (Triticeae) combat nitrification in wheat farming? Plant Soil (2007) 299:55–64.
2. G.V. Subbarao, et al. (2021) Enlisting wild grass genes to combat nitrification in wheat farming: A nature-based solution,Proc. Natl. Acad. Sci. U.S.A. 118 (35) e2106595118, https://doi.org/10.1073/pnas.2106595118 (2021).
3. Thamvithayakorn, P et al. 2025. Characterization and Whole-Genome Sequencing of Phytobacter palmae WL65, a Plant Growth-Promoting Rhizobacterium First Isolated from Rice Rhizosphere Soil in Thailand. Agriculture, 15(7), p.707.
4. Petroli, C.D., Subbarao, G.V., Burgueño, J.A. et al. Genetic variation among elite inbred lines suggests potential to breed for BNI-capacity in maize. Sci Rep 13, 13422 (2023). https://doi.org/10.1038/s41598-023-39720-3
5. Hannes Karwat, Masahiro Kishii, María Elena Cárdenas-Castañeda, Maria Itria Ibba, Victor Kommerell, Alison R. Bentley, Hans-Joachim Braun, Iván Ortiz-Monasterio. 2025. Nitrogen dynamics and yield performance of an elite bread wheat line with BNI capacity expressed in an alkaline soil, Field Crops Research, 334, 110172

Student profile

Essential for project: A background in crop/plant science, or agricultural sciences with a keen interest in phenotyping and modelling

Desirable for project: Prior experience working in wheat/cereals and roots phenotyping. Knowledge on coding and programming.

Minimum requirements for all FoodBioSystems applicants: An upper 2nd class degree (or equivalent) in a subject relevant to the project. Candidates with a lower class of Bachelors degree, but merit or above at Masters level will also be considered**. D**emonstrable skills in problem-solving, team-working, communication and time management.

Training

Project specific training opportunities: The student will be gaining skills in areas of crop physiology, phenotyping, image processing and modelling. Practical training and support e.g. on experimental design and execution, good laboratory practice, state-of-the-art imaging and modelling will be provided primarily by the supervisory team. Being based at Lincoln (LIAT) the student will have opportunities to interact with other doctoral students specialising in computer science and artificial intelligence and attend summer school. Training on microbial bar coding will be provided at Aberystwyth as well as using the phenomics facilities for root phenotyping. The selected candidate will be trained in discipline related topics (e.g. Bio-informatics, Statistics) as well as those promoting transferable skills such as entrepreneurship, leadership, and employability. Interdisciplinary skills will be acquired during this project.

FoodBioSystems training opportunities: Throughout their studentship, all FoodBioSystems doctoral researchers participate in cohort training that covers four key themes: food systems, big data (data analytics and modelling), business, and research fundamentals. All doctoral researchers complete a placement: either project-related with a non-academic (CASE) partner, or unrelated to the project and outside the academic environment (PIPS). Details of training are available on the DTP website: https://research.reading.ac.uk/foodbiosystems/training/.

Project supervision style

The student will meet with the lead supervisor (Dr Gaju) weekly for 1:1 progress discussions, with monthly meetings involving the full supervisory team (Gaju, Doonan, Lui and Griffiths). These will alternate between in-person and online formats to accommodate collaborators. The student will also be given the opportunity to attend (remotely) the NPPC biweekly group meetings and present from time to time. Quarterly review meetings will be used to assess milestones and adjust the project plan as needed. The student will also participate in lab group meetings and journal clubs to support peer learning and interdisciplinary engagement. Supervisors will provide feedback on written work (e.g. reports, drafts) within two weeks, ensuring timely support. Dr Lu will provide structured training and guidance on AI components, with dedicated sessions during imaging and data analysis phases.

Stipend (Salary)

FoodBioSystems DTP students receive an annual tax-free stipend (salary) that is paid in instalments throughout the year. For 2025/26 this is £20,780 and it will increase slightly each year at rate set by UKRI.

Equity Diversity and Inclusion

The FoodBioSystems DTP is committed to equity, 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 and include:

- Offering reasonable adjustments at interview for shortlisted candidates who have disclosed a disability or specific learning difference.
- Guaranteed interview and applicant mentoring schemes for applicants, with UK home fees status, from eligible under-represented ethnic groups who also meet academic eligibility criteria and the student profile essential for the project.

These are opt-in processes**.**

Our studentships can be offered to home students on a part-time basis, and studentship end date and stipend payments will be amended to reflect the part-time registration. The minimum registration for DTP funded part-time students is 0.5 FTE (studying an average of 20 hours per week over 8 years). We regret that part time registration is not available to international students due to complexities of visa restrictions.

Funding note

We welcome applications from candidates with Home/ROI fees and international fees status. This studentship is funded by UKRI and covers stipend, fees at Home/ROI rate, and research costs. The host university will not charge UKRI funded international students the difference between Home/ROI fees and international fees.
Costs that must be found from other sources or met by the individual student include:
Visa fees, healthcare surcharge, relocation costs and guarantor services.

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