Tackling the Threat of Take-All Disease of Wheat in a Changing Climate

Supervisory team:
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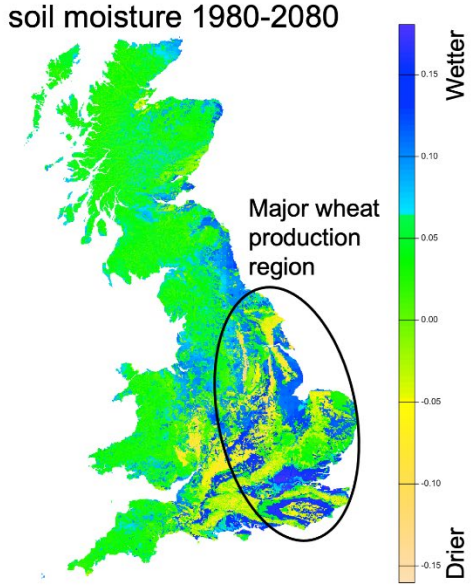
Host institution: University of Exeter (Streatham)
CASE partner: Syngenta Crop Protection AG

Project description:

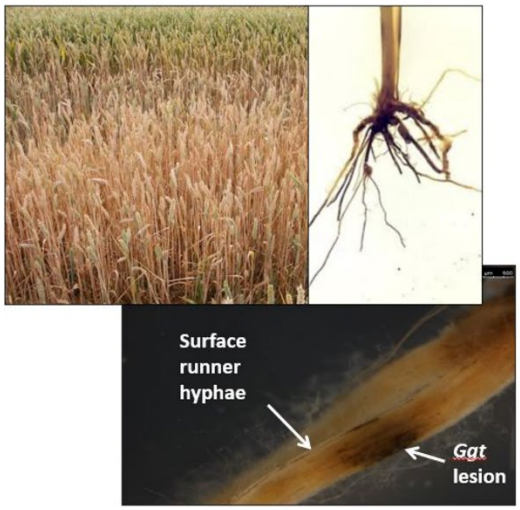
Background and Significance

Take-all, caused by the soil-borne fungal pathogen Gaeumannomyces tritici, is the most significant root disease affecting wheat globally, leading to reduced nutrient uptake and severe yield losses. The pathogen spreads through primary infection from soil inoculum and secondary infection via root contact, causing patches of grain with bleached spikes called "whiteheads." Currently, no resistant wheat cultivars or effective chemical controls are available, highlighting the urgent need for new management strategies, especially as climate change may exacerbate the disease. This project combines field work, controlled-environment experiments, mathematical modelling and bioinformatics to provide comprehensive skills training for a career in plant health and food security.

a) Projected change in winter soil moisture 1980-2080



b) Take-all disease of wheat



Objectives

This research aims to address take-all disease through four objectives:

1. Map the distribution of take-all in the UK and assess its impact on wheat yield.
2. Develop a dynamic model of take-all epidemiology incorporating climatic factors like soil moisture and temperature and management factors like crop rotation.
3. Review global take-all incidence in relation to climate and agricultural practices.
4. Investigate the role of the soil microbiome in take-all suppression and explore microbiome manipulation to enhance disease resistance.

Research Plan

1. Mapping and Yield Impact: Conduct field surveys across the UK to assess the prevalence of take-all using molecular diagnostics. The correlation between wheat yield and disease severity will be examined, focusing on how various wheat cultivars and crop rotations influence take-all inoculum buildup.
2. Epidemiology Model: Develop a predictive model to simulate take-all dynamics, factoring in soil moisture and temperature. The model will predict disease cycles under different climate scenarios and be validated with field data.
3. Global Incidence and Climate: Review the global distribution of take-all, focusing on how climate and management practices influence its spread. The analysis will identify regions most vulnerable to the disease under changing climatic conditions.
4. Soil Microbiome Role: Study the soil microbiome's role in disease suppression by identifying beneficial microbial communities. Controlled experiments will test the effects of microbial inoculants and soil amendments to enhance disease suppression.

Expected Outcomes

This project will provide new insights into take-all epidemiology and management, especially under future climate change scenarios. The predictive model will improve forecasting of disease outbreaks and how these can be managed, while microbiome-based interventions could offer sustainable solutions for disease control, enhancing wheat production resilience in the UK and globally. The project is supported by Syngenta Crop Protection, a global, science-based agtech company.

Our aim as the SWBio DTP is to support students from a range of backgrounds and circumstances. Where needed, we will work with you to take into consideration reasonable project adaptations (for example to support caring responsibilities, disabilities, other significant personal circumstances) as well as flexible working and part-time study requests, to enable greater access to a PhD. All our supervisors support us with this aim, so please feel comfortable in discussing further with the listed PhD project supervisor to see what is feasible.