OXFORD INTERDISCIPLINARY BIOSCIENCE
Doctoral Training Partnership

**Industrial CASE Studentship Advertisement – 2021-22**



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**Project Title:** *Using optimal control approaches to understand resistance in the management of* Septoria

**Brief description of project:**

Ecological decision problems, such as those encountered in agriculture, often require managing conflicts between short-term costs and long-term benefits. We have developed, through several BBSRC awards (standard and LINK grants: BB/C512702/1, BB/H01814X/1, BB/L00948X/1; BBSRC studentships: (BBS/S/J/2005/12055, BB/K011936/1 , BB/R505067/1, BB/G006172/1; BBSRC IAA: BRR00120) methods for optimally solving these sorts of ecological problems particularly in understanding the management of disease spread and agricultural pests (e.g. Khamis et al. 2018; Rawson et al. 2020a,b). From an agricultural perspective, these tools have been used to develop solutions to understand how to combine different control technologies (Hackett & Bonsall 2017), as well as preliminary approaches to the dynamics and management of resistance evolution (Hackett & Bonsall 2019; Zhou et al. 2018, 2019).

Using these tools and our approaches to resistance management, we are now in a unique position to leverage working with Syngenta on the application of these dynamic programming methods to understand management of *Septoria* (*Zymoseptoria tritici*) resistance to fungicides.

Preliminary work with Syngenta suggests that there is a lack of good agronomic tools that can help farmers to help manage impact of resistance over multiple years and a scalable tool and gives good (80-90%) indications would be highly desirable. Current models tend to focus on predictions of the disease severity rather than how to manage this agricultural problem. As *Septoria* presents a large resistance risk and one where a reasonable volume of legacy data is available, we can develop a PhD project that will combine mathematical modelling, data analysis with potential empirical work.

The PhD student will begin this project by familiarizing themselves with the existing dynamic programming tools and optimal control approaches developed for resistance management with the aim of exploring potential novel approaches and applications of these tools for agronomy. It is expected that the initial approach to this resistance management problem will be the development of a mathematical model representing the population genetic and population ecological dynamics of *Septoria*. Working in collaboration with the Syngenta team, the student will develop a robust mathematical model for *Septoria* resistance spread. This robustness will involve on applied details on, for example, levels of compliance of farmers towards resistance management strategies and more fundamental aspects of the inherent variability of disease epidemiology and evolutionary

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biology. Following on from this, the optimal control approaches will focus on approximate dynamic programming techniques (such as look-ahead methods) for understanding how to predict and develop management interventions for *Septoria* control. It is expected that findings from this initial work could then be developed into more refinements of the modelling work and/or, through the design of short-term ecological experiments, tool validation and tests of the tool's predictions. Such developments will contribute to more effective resistance-management interventions by taking advantage of the flexibility provided by dynamic programming coupled with the development of real-time resistance-monitoring methods currently being driven by Syngenta. An ultimate goal in this research and development is to provide growers with actionable information to tackle resistance evolution as it emerges.

Locations: Oxford (UK); Syngenta (Switzerland)

**Attributes of suitable applicants:**

Essential: Good degree (1/2.i) in a quantitative subject  (e.g. mathematics, statistics) or a biology degree with a high level of numeracy.

Desirable: Students with an interest in the application of mathematical methods to solving biological problems and working closely with industrial partners to develop quantitative methods and approaches for understanding resistance management.

**Funding notes:**

This project is funded for four years by the Biotechnology and Biological Sciences Research Council UKRI-BBSRC. UKRI-BBSRC eligibility criteria apply (https://www.ukri.org/files/funding/ukri-training-grant-terms-and-conditions-guidance-pdf/). Successful students will receive a stipend of no less than the standard UKRI stipend rate, currently set at £15,285 per year, which will be supplemented by the industrial partner with additional £4,000 per year.

*This project is supported through the Oxford Interdisciplinary Bioscience Doctoral Training Partnership (DTP) studentship programme. The student recruited to this project will join a cohort of students enrolled in the DTP's interdisciplinary training programme, and will participate in the training and networking opportunities available through the DTP. For further details, please visit www.biodtp.ox.ac.uk. The DTP and its associated partner organisations aim to create a community that is innovative, inclusive and collaborative, in which everyone feels valued, respected, and supported, and we encourage applications from a diverse range of qualified applicants.*