Ralstonia Phage Biocontrol

Ville Friman and Andrea Harper
University of York

Plant pathogenic bacteria cause considerable economic losses to food production systems. The main reason for this is that hardly any effective control methods exist to mitigate this damage. In this proposal, we will develop a predictive framework and holistic understanding of how to control plant pathogenic *Ralstonia solanacearum* bacterium in the plant rhizosphere microbiomes by using bacteria-specific viruses, phages.

We will focus on three key aspects that make phages especially useful tools for crop protection. First, we will explore the advantage of phage specificity and test if we can 'precision edit' microbiomes by selectively targeting only the pathogen. This is important not only for the efficacy but also for the safe use of phages as they should not cause collateral damage to the surrounding microbiome in the rhizosphere.

Second, we will determine the evolutionary consequences of phage selection for pathogen competitiveness and virulence using metabolic modelling and direct experimentation. While it is likely that pathogens can rapidly evolve resistance to phages, this is often costly to the pathogen. Phages could thus be used as 'evolutionary tools' to weaken the pathogen by selecting resistance adaptations that incur high metabolic burden or impair virulence gene expression.

Third, we will explore if phage-mediated changes in pathogen virulence and microbiome composition predictably alter plant immune responses having potential additional beneficial effects on the plant health. Here, we will move beyond pathogen-centric view to build a holistic understanding of community-level feedbacks by systematically exploring responses in plant gene expression when challenged with phage resistant and susceptible pathogens in the absence and presence of natural rhizosphere microbiome. Finally, the most promising phages will be selected for industrial manufacturing and their biocontrol efficacy and safety validated in greenhouse trials using potato.

To achieve these goals, we will bring together an interdisciplinary research team consisting of academics and industry partners experienced in ecology and evolution of phage-bacteria-plant interactions, genomics, metabolic modelling and plant transcriptomics.

The proposed research is innovative, timely and pushes the boundaries of traditional crop protection to precision control of plant pathogenic bacteria in the plant rhizosphere using phages.