

Harnessing beneficial microorganisms for predictive and sustainable crop protection

Protecting crops from diseases is essential for food production, but it comes with a major challenge: how can we maintain effective crop protection while reducing our dependence on chemical pesticides? Plant pathogens cause substantial losses in agriculture, while pesticide resistance, environmental concerns and a changing climate are increasing the need for more sustainable approaches. One promising approach is biological control, which uses beneficial organisms to suppress plant pathogens and other harmful organisms. Plants naturally live together with diverse communities of microorganisms, some of which can contribute to their protection. Beneficial fungi, for example, can suppress plant pathogens through competition for space and nutrients, production of antimicrobial compounds, or direct interactions with pathogens. Harnessing these microorganisms as biological control agents offers an opportunity to complement conventional crop protection and reduce reliance on chemical pesticides.

However, biological control does not always work predictably. Even strains belonging to the same microbial species can differ significantly in their ability to suppress disease, survive environmental stress and colonise plants. A microorganism that performs well in the laboratory may not provide the same level of protection under greenhouse or field conditions. Why are some strains more effective than others? Can we identify characteristics associated with successful biological control? And could such knowledge eventually help us select microorganisms that perform more reliably under real growing conditions?

My research uses beneficial fungi, including *Clonostachys rosea* and *Aureobasidium pullulans*, as models to explore these questions. I have studied the potential of beneficial fungi to suppress plant-parasitic nematodes and important plant diseases. This includes research on grey mould and anthracnose of strawberry, using approaches ranging from laboratory studies to greenhouse and field experiments. Building on this work, I am now investigating why strains of *A. pullulans* differ in their ability to suppress disease. Advances in whole-genome sequencing and other molecular tools provide new opportunities to explore whether genetic differences among strains can help explain this variation. In this lecture, I will discuss how such knowledge could help move biological control from largely empirical screening towards more informed and predictive approaches. However, genetic characteristics alone may not determine the success of a biological control agent. Its performance also depends on interactions with the plant, the pathogen, other microorganisms and the surrounding environment.

By bringing together biological control, genomics and ecological understanding, we can more reliably choose the right beneficial microorganism for the right crop and growing conditions. This would make microbial crop protection more predictable and contribute to resilient production systems with less dependence on chemical pesticides - a prerequisite for sustainable food production in a changing climate.