

A race to dominate: Breeding to fortify plant defence as pathogens evolve

Feeding a growing population requires agriculture to produce more food, but achieving this sustainably is an increasingly challenging task. Crop production must use resources efficiently, minimize environmental impacts, and rely less on external inputs. Meeting these demands is becoming more challenging as agricultural land is limited, climate change alters growing conditions, and pressure from pests and pathogens increases.

Diseases caused by plant pathogens substantially reduce crop yields and product quality globally, with annual losses estimated to exceed 200 billion dollars, and threaten food security. Traditional agricultural practices to control pathogen-induced diseases in crops are not always reliable. Repeated pesticide application, which is often effective for controlling diseases in agricultural fields, poses environmental and health risks, incurs additional costs for food producers, risks the emergence of pesticide-resistant pathogen variants, and affects beneficial organisms. Thus, there is an urgent need to reduce pesticide applications and promote integrated approaches based on host plant resistance.

Developing and deploying disease resistant varieties of major crops has been a long-standing priority for limiting pesticide applications and reducing yield and quality losses. In this context, plant breeders have focused on developing high-yielding and disease resistant varieties. However, plant pathogens are evolving, and subsequently emerging pathogen variants can break the host resistance in improved crop varieties. Growing evidence also shows that ongoing climate change (e.g., rising temperature, milder winter, and elevated carbon dioxide) may favour pathogens, leading to increased disease severity. Hence, without continued efforts to strengthen host resistance in major crops, evolving pathogens and climate change could lead to greater crop losses and more frequent disease outbreaks. Despite decades of breeding efforts, complete resistance to some pathogens has not been found in evaluated varieties of crops collected from several countries. Understanding how these pathogens evolve is therefore critical for developing effective and durable resistant varieties.

My lecture focuses on the impact of pathogens on food production, and on understanding the dynamic interactions between plants and pathogens in agricultural fields. It examines how these interactions shape the co-evolution of plants and pathogens, as well as approaches for identifying novel sources of resistance in a diverse crop germplasm and revealing the genetic basis of resistance traits. The lecture also explores how this knowledge can be translated into new methods to accelerate the development of resistant crop varieties and help agriculture cope with fast-evolving pathogens. I will showcase studies aimed at understanding why plants are unable to develop complete resistance to certain pathogens. I will also present findings from my research, together with the datasets and genetic resources generated, contributing to the improvement of disease resistance in crops. The lecture will also highlight my future research directions and their potential contribution to the Sustainable Development Goals by supporting low-input and sustainable crop production in Sweden and globally.