Imperial College London

Natural Environment Research Council

2024_53_DoLS_TB: Plant Immunity in a Changing Climate: The Mode of Action of NLR Immune Receptors in High Temperatures

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Plant disease resistance is fundamental to agriculture, safeguarding crop health and productivity. However, a significant challenge arises as most plant disease resistance proteins, including NLR (Nucleotide-binding, Leucine-rich Repeat) immune receptors, exhibit reduced effectiveness at temperatures above 28 degrees Celsius. This temperature sensitivity has critical implications, making crops more susceptible to diseases and pests, particularly in the context of increasing global temperatures and climate change. Despite its importance, the underlying reasons for this temperature sensitivity remain poorly understood. This project aims to address this knowledge gap by investigating the mode of action of NLR immune receptors in plants exposed to high temperatures.

We will pursue following specific objectives:

(1) Characterize NLR Activation at High Temperatures: Investigate the mechanisms governing the activation or inactivation of NLRs under high-temperature stress conditions.

(2) Assess Temperature-Induced Alterations in NLR Function: Examine how elevated temperatures impact the functionality of NLRs, including their ability to recognize pathogens and initiate immune responses.

(3) Identify Temperature-Responsive NLR Variants: Explore the existence of temperature-responsive variants of NLRs and their potential roles in plant immunity under high-temperature stress.

(4) Address Implications for Disease Resistance: Evaluate the consequences of elevated temperatures on plant disease resistance and susceptibility, taking into consideration the NLR-mediated defense pathways.

To achieve our goals, we will select ten agriculturally important NLR genes and explore their mode of action under elevated temperatures. To gain insights into temperature sensitivity, we will generate NLR mutants through random PCR mutagenesis or create chimeric NLRs. This approach will help us identify key NLR regions responsible for mediating temperature sensitivity. Our study will employ a combination of cell biology and biochemistry techniques to delve into NLR oligomerization and activation. We will place particular emphasis on utilizing cryo-electron microscopy (cryo-EM) and high-resolution confocal microscopy to visualize oligomeric NLRs that execute immune functions.

This project will unravel the complexities of NLR immune receptor function in the context of high-temperature stress, particularly addressing the temperature sensitivity observed in most plant disease resistance proteins. The findings from this research are critical, given the challenges posed by increasing global temperatures and the urgent need to adapt plant immunity strategies for sustainable agriculture in a changing climate