Seeing the unseen:

Pre-symptomatic foliar disease detection and surveillance using plant optics

Da-Young Lee

Pohang University of Science and Technology

For centuries, human vision-based disease severity assessment has served as the foundation of plant health evaluation. However, the transition from heterogeneous small-farm production systems to modern intensive agricultural systems designed for mass production has fundamentally altered the plant disease landscape. The widespread adoption of high-yielding cultivars, tighter planting densities, and large-scale monoculture production has created environments increasingly conducive to sporadic disease outbreaks and large-scale epidemics. At the same time, climate change and globalization are accelerating the emergence and transboundary movement of plant pathogens, resulting in the appearance of diseases in regions where they were previously absent. The growing interconnectedness among agricultural intensification, increased disease pressure, climate-related risks, and global food security challenges underscores the urgent need for high-throughput, accurate and objective methodologies beyond conventional visual assessment approaches. In this context, the integration of plant optics and artificial intelligence is emerging as a promising new frontier for plant disease detection, quantification, and surveillance. This seminar will discuss conventional crop disease rating systems, their applications and limitations, and alternative approaches that can enhance the accuracy and objectivity of disease assessment. Case studies on both symptomatic and pre-symptomatic disease detection under controlled and field conditions will also be explored. Finally, current research utilizing within-leaf light scattering dynamics as an optical probe for detecting pre-symptomatic foliar disease development will be presented.