Application of Spectral Imaging Phenotyping for Screening Powdery Mildew-Resistant Cucurbitaceae Varieties and Evaluating Control Efficacy

Abstract

Plant disease identification has traditionally relied on experts' accumulated experience, with subsequent confirmation by techniques such as optical microscopy, immunoassays, or molecular-biological methods to accurately identify pathogens and assess disease severity. For disease-incidence surveys and resistance-breeding research, experts historically established disease indices based on visually discernible plant phenotypes. However, rapid advances in molecular breeding have outpaced these manual indices, which no longer satisfy current research rigor. Spectral imaging–based phenotyping provides far more detailed information, enabling direct correlation with genotypic data and substantially reducing the errors inherent in human visual assessment. In this study, we integrated spectral imaging with a controlled-environment chamber optimized for Cucurbitaceae powdery mildew development. We then applied machine-learning algorithms to develop robust disease-recognition models and establish a high-throughput, phenotyping-driven selection system for powdery mildew resistance. This system streamlines screening, reduces labor requirements, and supports precise, large-scale trials. To ensure reproducibility and rigor, we defined standardized evaluation criteria and diagnostic workflows, laying the groundwork for consistent assessment of resistance traits and the efficacy of novel disease-control agents.

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RESEARCH AREAS AND EXPERTISE

- General area: Agricultural technology application
- Specific area: Plant pathology, Plant pathogen identification

SELECTED AWARDS AND RECOGNITION

- Paper Reviewer, APBB platform, FFTC, 2022-
- Recommended Participant, APEC High Level Policy Dialogue on Agricultural Biotechnology, APEC, 2021-2024

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