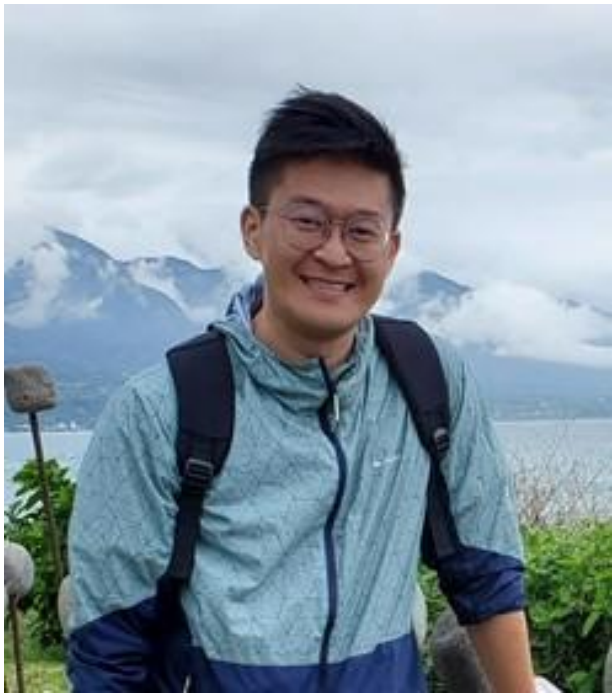
Non-destructive Detection for the Early Drought Stress Status of Tomato (*Solanum lycopersicum*) by Spectroscopy and Deep Learning

Abstract

This study introduces a deep learning architecture termed 1D-SP-GC Net, designed to analyze Vis/NIR (visible to near-infrared) spectoscopic data obtained from the canopy leaves of tomato plants (*Solanum lycopersicum*). The 1D-SP-GC Net was employed to develop a non-destructive model for detecting early drought physiological status in tomatoes. Compared to commonly used models for spectral data analysis, such as Partial Least Squares (PLS) regression, Random Forest (RF), and Convolutional Neural Networks (CNN), the 1D-SP-GC Net demonstrated superior prediction accuracy (>95%). Additionally, by utilizing Gradient-weighted Class Activation Mapping (Grad-CAM) within the 1D-SP-GC Net architecture, the study identified specific spectral bands that significantly contributed to the model's discriminative capability. The 1D-SP-GC Net effectively detected early drought conditions in tomato plants, offering a timely warning system for farmers to implement appropriate agricultural practices, thereby mitigating the impact of drought stress on the quality and yield of tomatoes.



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RESEARCH AREAS AND EXPERTISE

- General area: Biochemistry and Biostatistics
- Specific area: Plant phenotyping

SCIENTIFIC ACTIVITY

- 2023: Summer School on Image Analysis for Plant Phenotyping. Wageningen University and Research. Nederland.
- 2018: Visiting Scholar. Australian Plant Phenomics Facility (APPF). Australia.
- 2017: Machine Learning for Big Visual Data. IEEE International Elite School. Taiwan.

Yuan-Kai Tu earned his Bachelor's degree in Natural Science Education from the University of Taipei, Master's degree in Biochemistry from National Taiwan University, and Ph.D. in Agronomy from National Chung Hsing University, Taiwan. He commenced his research career at the Genetic Resources and Biotechnology Division of the Agricultural Research Institute (TARI). With a strong foundation in biochemistry and biostatistics, Dr. Tu specializes in applying advanced quantitative methods to plant genotyping and phenotyping analyses. His research endeavors aim to elucidate the correlations within biological data. In addition to his research activities, Dr. Tu is actively involved in the strategic planning and development of phenomics research initiatives at TARI.