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IDENTIFICATION OF CITRUS DISEASES, PESTS, AND DISORDERS USING DEEP LEARNING

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Abstract

Taiwan's warm climate offers favorable conditions for citrus production, making it the most economically valuable fruit crop in the country. Citrus trees are perennial and mainly propagated asexually. Long-term exposure and limited genetic diversity make them more susceptible to infection by various pathogens. In practice, diagnosis often relies on farmers' experience, which can be subjective despite their familiarity with local conditions. Microscopic examination by plant pathologists offers greater accuracy but remains time-consuming and labor-intensive. To support efficient monitoring, we developed an image-based classification system for automatically identifying common citrus leaf symptoms. The dataset includes 1,494 images covering five categories: canker, greasy spot, leaf miner, thrips, and sunburn. Using a Vision Transformer (ViT) architecture, the system classifies leaf symptoms from RGB images. Experimental results show that the model achieves an overall accuracy of 98.67%, effectively distinguishing most symptom types. Misclassification analyses revealed difficulty in differentiating visually similar categories, particularly leaf miner versus thrips and greasy spot versus leaf miner. These findings demonstrate the potential of deep learning-based approaches for citrus disease and pest management. Future work will aim to expand datasets and integrate object detection for precise localization.

Keywords: Citrus Leaf Classification, Disease and Pest Classification, Deep Learning, Vision Transformer, Image-Based Monitoring

INTRODUCTION

Citrus is the most economically important fruit crop in Taiwan, cultivated extensively under favorable subtropical conditions. However, due to their perennial nature, asexual propagation, and limited genetic diversity, citrus trees are highly susceptible to various pathogens and pests. Disease and pest identification has traditionally relied either on farmers' field experience, which is often subjective, or on microscopic diagnosis by plant pathologists, which is time-consuming and labor-intensive. To improve monitoring efficiency and reduce diagnostic burden, this study presents a deep learning-based system for automatic classification of citrus leaf symptoms using RGB imagery.

MATERIALS AND METHODS

This study focuses on developing a classification model for citrus leaf symptom identification. Field sampling was conducted in central and southern Taiwan, and images were captured using smartphones and digital cameras under natural lighting conditions. Each image was reviewed and labeled by plant pathology experts to ensure annotation accuracy. A total of 1,494 RGB images were collected between March and May 2025 in collaboration with the Taiwan Agricultural Research Institute (TARI).Five common symptom categories were

selected as classification targets: canker, greasy spot, leaf miner, thrips, and sunburn. Canker, greasy spot, leaf miner, and thrips mainly manifest on leaves, while sunburn is typically observed on fruits. These categories were determined based on expert consultation and field relevance. The dataset was divided into training and validation sets using an 8:2 ratio.
A Vision Transformer (ViT) architecture was adopted to develop the classification model. The Tiny-ViT variant (5.4 million parameters) was selected to match the dataset scale and computational requirements. The model was trained for 100 epochs using the Adam optimizer with a learning rate of 0.001.

RESULTS & DISCUSSION

The proposed classification model achieved an overall accuracy of 98.67%, with perfect classification for canker and sunburn. Minor misclassifications occurred between leaf miner, thrips, and greasy spot, likely due to visual similarities in symptom patterns. Leaf miner produces tunnel-shaped feeding marks, while thrips leave elongated scars, but these features may converge when lesions enlarge or vary in color. Greasy spot was also misclassified as leaf miner in some cases, especially when dark clusters resembled pest trails. These results indicate that higher-resolution imagery and localized features could further improve fine-grained discrimination.

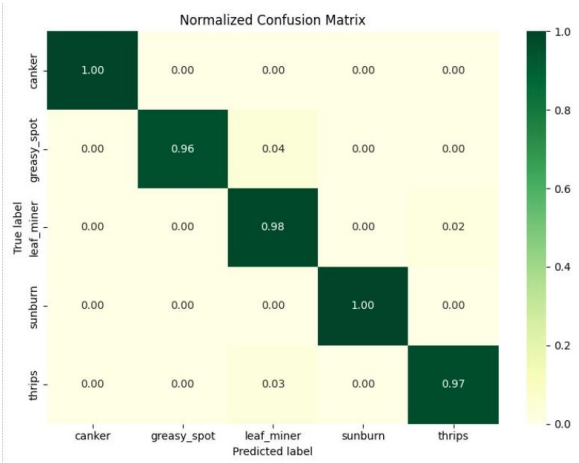

Figure 1. Confusion matrix of model predictions across 5 classes.

CONCLUSIONS

This study demonstrates the feasibility of applying deep learning for automatic classification of citrus leaf symptoms. Despite the limited dataset size, the Tiny-ViT model achieved high accuracy and effectively distinguished most symptom categories. The system shows strong potential for supporting field monitoring and reducing diagnostic workload. Future work will focus on expanding the dataset, incorporating object detection for symptom localization, and exploring deployment through user-friendly platforms to enhance accessibility and practical use in agricultural settings.

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