Modeling the Effects of Greenhouse Environmental Factors on Soft Rot Incidence in Phalaenopsis

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ABSTRACT

Phalaenopsis spp. is one of Taiwan's most important ornamental crops for export. However, during greenhouse cultivation, Phalaenopsis is frequently threatened by bacterial soft rot (*Erwinia spp.*), particularly under high-temperature and high-humidity conditions that accelerate pathogen spread and cause severe losses in seedlings. This study was conducted in a Phalaenopsis greenhouse located in Houbi District, Tainan, Taiwan. The greenhouse contained 21 planting beds, which were further divided into 16 grid units (10 × 10 m each). Temperature and humidity sensors were installed to monitor environmental conditions, while field investigations were carried out to record disease symptoms and map the spatial distribution of soft rot hotspots. The results revealed that bacterial soft rot incidence was mainly concentrated in planting beds 1, 20, and 21, with rates ranging from 1.04% to 2.26%. The corresponding sensor data from these areas—located near the ventilation fans—indicated significantly higher temperatures compared with other zones. In addition, poor air circulation in these regions led to humidity retention, resulting in localized high-temperature and high-humidity microclimates that promoted disease outbreaks. Investigating the spatial distribution of bacterial soft rot in Phalaenopsis greenhouses and analyzing its relationship with environmental factors will be valuable for developing early warning systems to support disease management and prevention.

Keywords: Phalaenopsis, Soft Rot (*Erwinia spp.*) Disease, Environmental sensing

INTRODUCTION

Phalaenopsis orchids (*Phalaenopsis spp.*) are among Taiwan's most valuable floricultural crops, particularly in the potted flower export sector, where they hold a significant share of the global market. They rank among the top items in Taiwan's cut flower and potted plant export value (Wu, 2013; Agriculture and Food Agency, 2022). The orchid industry in Taiwan is internationally renowned for its rich varietal diversity, advanced breeding programs, and sophisticated flowering induction techniques. Despite advances in greenhouse facilities and climate control, diseases remain a major production challenge. Environmental factors such as temperature, humidity, light intensity, and air circulation strongly influence pathogen

development and infection risks (Chien *et al*., 2015; Lin *et al*., 2020). Understanding the impact of greenhouse microclimates on disease expression in Phalaenopsis seedlings is therefore essential for both scientific insight and practical disease management.

MATERIALS AND METHODS

2.1 Greenhouse Facility and Sensor Deployment

Environmental sensors for temperature, humidity, and light intensity were installed in a 40 m × 40 m greenhouse (Fig.1). The greenhouse contained 21 rows of standardized cultivation beds. Ventilation fans were positioned at the front end to discharge heat, while a cooling pad system was located at the rear to maintain stable thermal and humidity conditions. In addition, ten circulation fans were installed to enhance airflow, ensuring a stable microclimate and improving measurement representativeness and accuracy.
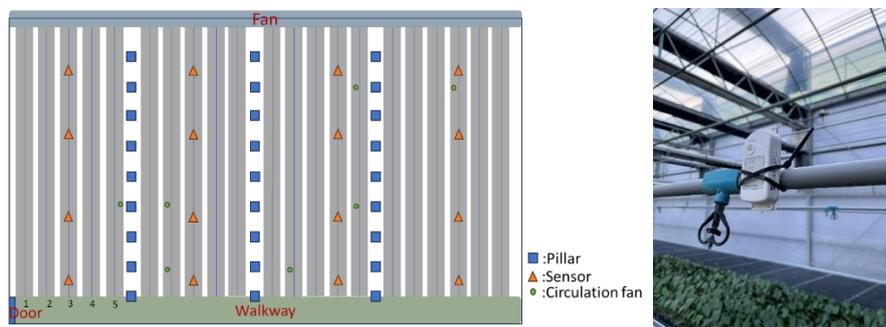

Fig.1 Experimental site and sensor deployment

2.2 Data Analysis

Symptom occurrence was integrated with corresponding environmental data across different time points to construct disease incidence time series. Correlation and trend analyses were performed to evaluate the potential influence of environmental factors on symptom development. Based on these results, disease risk indicators and optimized environmental control strategies were proposed, providing practical references for disease management and greenhouse climate control in Phalaenopsis cultivation.

RESULTS & DISCUSSION

This section presents the experimental results, focusing on the analysis of environmental factors within the Phalaenopsis cultivation greenhouse, including spatial variation in temperature, humidity, and light intensity, as well as their relationship to the incidence of bacterial soft rot. The study further evaluated the potential of using these factors for disease risk prediction. Disease incidence of bacterial soft rot was mainly observed in beds 1, 20, and 21 with rates ranging from 1.04% to 2.26%(Fig.2).

Sensor data showed that S11 and S16, located near the exhaust fan side, recorded higher temperatures than other sites, consistent with the pathogen's preference for warm conditions. In contrast, S15 exhibited unusually high humidity, likely due to uneven airflow or localized moisture retention. These microclimatic variations matched the spatial distribution of disease outbreaks, highlighting the role of localized hot and humid zones in disease development.
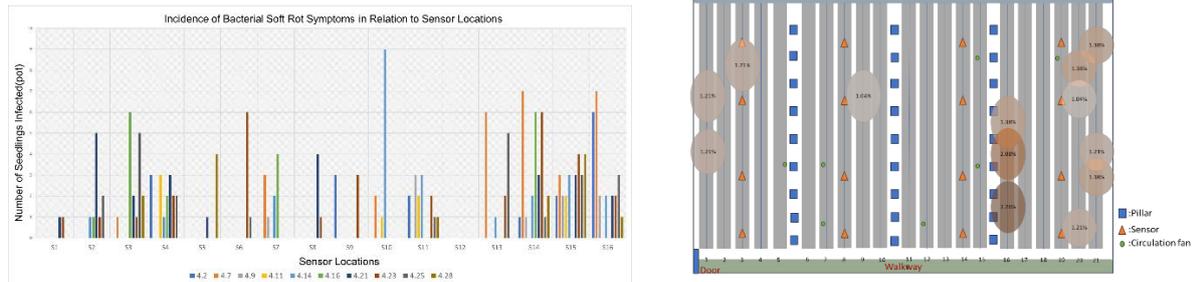
Fig.2 Correlation between environmental factors and incidence of orchid disease symptoms

CONCLUSIONS

This study provides a preliminary exploration of the conditions that facilitate disease occurrence and hotspot distribution. However, to further clarify the causes of orchid disease symptoms, continuous integration of environmental data collection and large-scale symptom sampling is required. Future work will focus on incorporating key parameters into AI-based training models. Moreover, since the experimental site is a commercial orchid greenhouse, differences in cultivation practices can also be considered as contributing factors to disease expression. While regional environmental factor analysis has enabled the identification of high-incidence areas, developing effective strategies to reduce disease risks remains a critical challenge for Phalaenopsis cultivation.

ACKNOWLEDGEMENTS

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