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Advances in Plant Pathology Research

Perspective

Eco-Friendly Strategies for Managing Soil-Borne Plant Pathogens in Tropical Argo-Ecosystems

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INTRODUCTION

Soil-borne fungal pathogens pose a significant threat to agricultural productivity, particularly in tropical agro-ecosystems were environmental conditions Favor rapid pathogen proliferation. This study evaluates the effectiveness of integrated disease management (IDM) strategies combining biological control agents, cultural practices, and resistant crop varieties to mitigate the impact of major soil-borne pathogens. Field and laboratory experiments were conducted to assess disease incidence, pathogen suppression, and yield improvement. Results indicate that the integration of Trichoderma harzianum, crop rotation, and resistant cultivars significantly reduced disease severity by up to 65% and increased crop yield by 40% compared to untreated controls. The findings highlight the importance of sustainable and eco-friendly approaches in managing plant diseases while reducing reliance on chemical fungicides.

Plant diseases caused by soil-borne fungi are a major constraint to agricultural productivity worldwide, especially in tropical regions characterized by high humidity and temperature. Pathogens such as Fusarium spp, Rhizoctonia solani, and Pythium spp. cause severe yield losses in a variety of crops. Traditional control methods rely heavily on chemical fungicides, which can lead to environmental contamination, pathogen resistance, and increased production costs.

Integrated disease management (IDM) has emerged as a sustainable alternative, combining biological, cultural, and genetic approaches to control plant diseases. This study aims to evaluate the effectiveness of IDM strategies in controlling soil-borne fungal pathogens and improving crop productivity in tropical agro-ecosystems.

The study was conducted in a tropical agricultural region characterized by sandy loam soil, average temperatures of 25–32°C, and annual rainfall of approximately 1200 mm.

A randomized complete block design (RCBD) was used with four treatments:

- T1: Control (no treatment)
- T2: Chemical fungicide application
- T3: Biological control (Trichoderma harzianum)
- T4: Integrated approach (biocontrol + crop rotation + resistan tvariety)

Each treatment was replicated three times.

Soil samples were collected and pathogens were isolated using standard plating techniques. Identification was based on morphological and microscopic characteristics.

- Disease incidence (%)
- Disease severity index (DSI)
- Crop yield (kg/ha)
- Soil microbial activity

Data were analyzed using ANOVA, and treatment means were compared using Duncan's Multiple Range Test (DMRT) at $p \leq 0.05$.

The integrated treatment (T4) showed the lowest disease incidence (18%) compared to control (52%). Disease severity was reduced significantly in T4, followed by T3.

The highest yield was recorded in T4 (4.2 t/ha), followed by T3 (3.6 t/ha), while the control recorded the lowest yield (2.5 t/ha).

Soils treated with Trichoderma harzianum showed enhanced microbial activity, indicating improved soil health.

The results demonstrate that integrated disease management strategies are more effective than single-method approaches in controlling soil-borne pathogens. The use of biological control agents such as Trichoderma not only suppresses pathogens but also enhances soil microbial diversity. Crop rotation disrupts the life cycle of pathogens, while resistant varieties reduce susceptibility.

The reduced effectiveness of chemical fungicides compared

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to IDM highlights the need for sustainable alternatives in modern agriculture.

CONCLUSION

Integrated disease management offers a viable and eco-friendly solution to combat soil-borne fungal pathogens in tropical agro-ecosystems. The combination of biological control, cultural practices, and resistant varieties significantly improves crop health and productivity. Future research should focus on optimizing these strategies for different crops and environmental conditions.