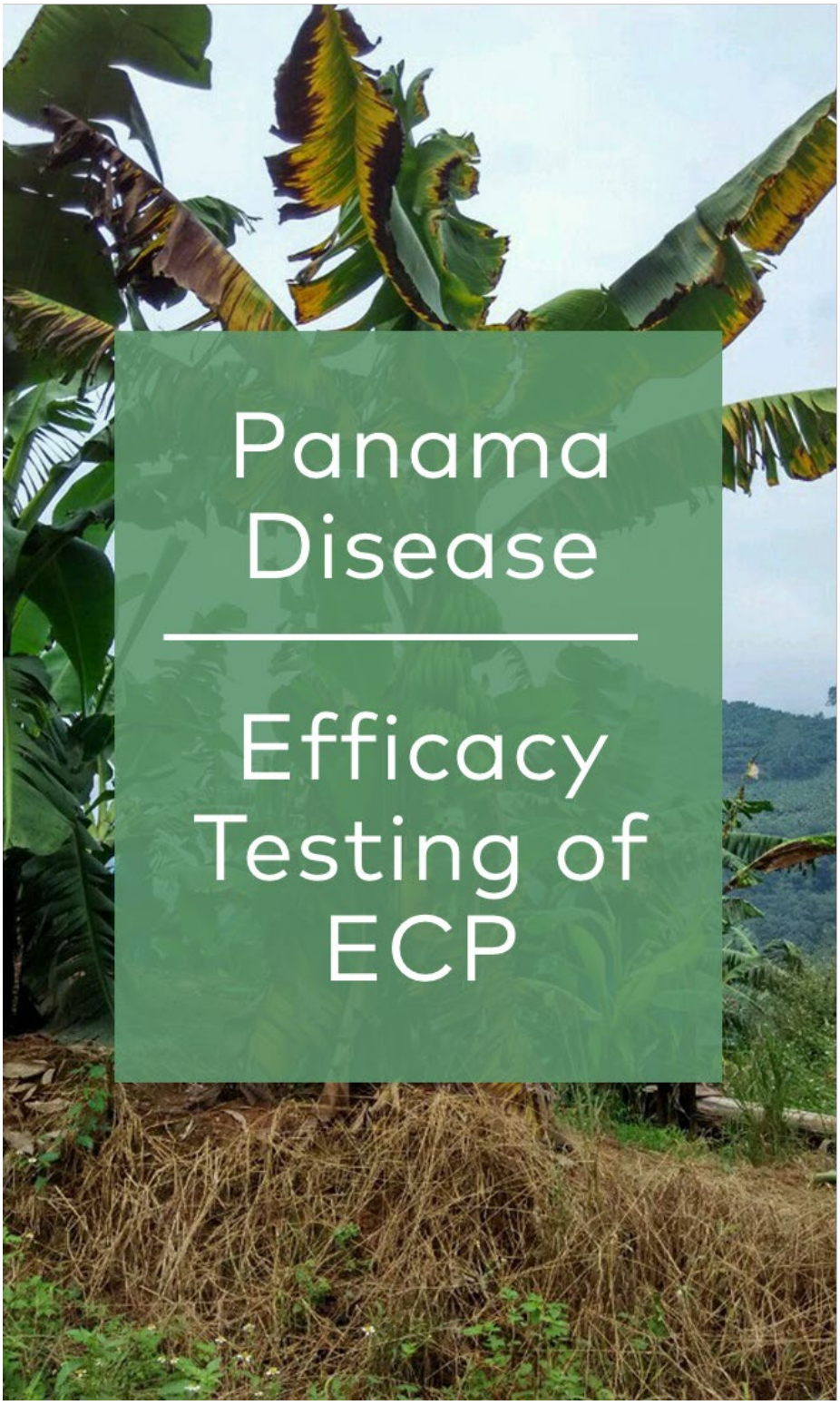
TMRW ECO



1 Executive Summary

This summary presents the results of a comprehensive 24-month field trial evaluating the efficacy of EcoClearProx ("ECP") against Panama disease caused by Fusarium oxysporum f. sp. cubense Tropical Race 4 (TR4) in banana cultivation. The study demonstrates significant preventive efficacy, yield enhancement, and complete spore elimination capabilities, positioning ECP as a breakthrough technology in TR4 management.

Key Findings:

- 100% spore eradication in surface water at low concentrations
- 40% reduction in TR4 infection rates with monthly preventive treatment
- Sustained efficacy across two complete harvest cycles
- Demonstrated yield increases and accelerated harvest timing
- Potential curative/ suppressive effects with temporary symptom reversal

2 Introduction and Background

2.1 The TR4 Challenge

Panama disease, caused by the soil-borne fungus Fusarium oxysporum f. sp. cubense, represents one of the most significant threats to global banana production. Tropical Race 4 (TR4) is particularly devastating, having spread from Southeast Asia to affect banana-growing regions worldwide. The pathogen causes vascular wilt, leading to plant death and rendering soil unsuitable for banana cultivation for decades.

Current management strategies remain largely ineffective once TR4 establishes in soil systems. The disease's persistence, ability to survive in soil for extended periods, and transmission through water sources have made it one of the most challenging plant pathogens to control.

There is no cure. Prevention (Bio-Security) and containment are the only effective strategies so far.

3 Efficacy Testing of EcoClearProx (ECP) – Laboratory

The efficacy of ECP was evaluated through controlled laboratory exposure of TR4 conidia and chlamydospores to varying concentrations of ECP (0.01% to 1%) over defined incubation periods (15 to 300 minutes).

3.1 Efficacy against Conidia Spores

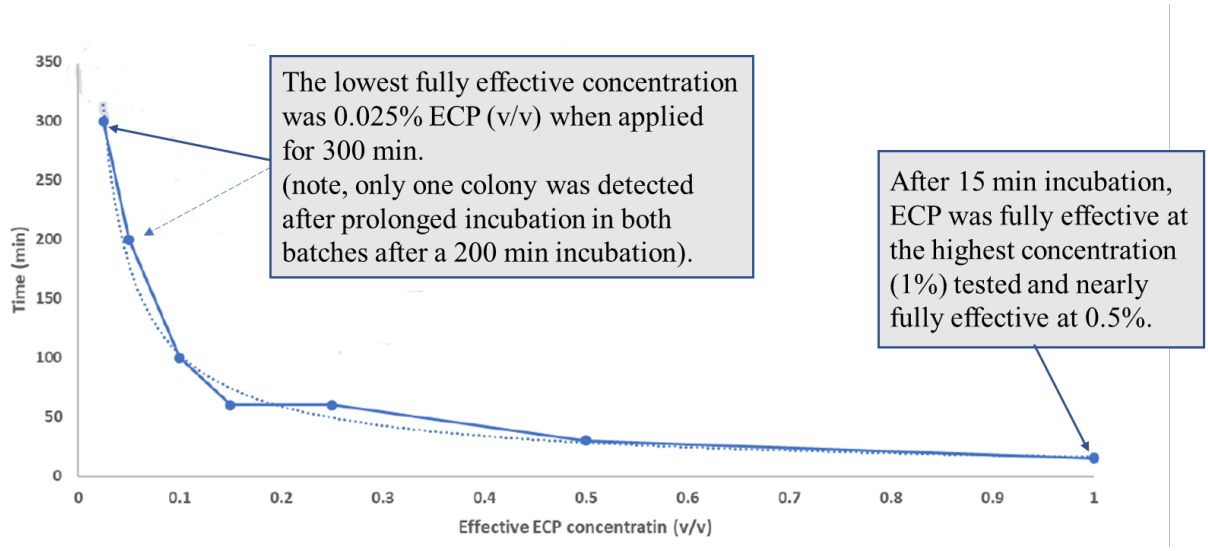


Figure 1: Efficacy Curve – ECP vs. Exposure Time and Concentration (Conidia Spores)

3.2 Efficacy against Conidia Spores

Exposing chlamydospores to ECP concentrations was fully effective at 0.1% when applied for 200 min. At a concentration of 1%, ECP was fully effective after 30 min incubation.

3.3 Summary

- ECP demonstrates time- and concentration-dependent fungicidal activity.
- At a 1% concentration, complete eradication of TR4 spores is achieved within 30 minutes.
- Lower concentrations (0.1%) are effective with longer exposure (200 minutes).

4 Efficacy Testing of EcoClearProx (ECP) – Field Trial

4.1 Research Objective

This study aimed to evaluate EcoClearProx as both a preventive and curative treatment against TR4 under natural field conditions, addressing the critical gap in effective TR4 management solutions.

4.2 Trial Design and Location

- **Study Period:** July 2023 to July 2025 (24 months)
- **Supervision:** Wageningen University & Research
- **Location:** Abandoned banana plantation with highly TR4-infested soil
- **Population:** 336 tissue-cultured banana plants

4.3 Plant Material and Site Preparation

- **Variety:** Grande Naine (Cavendish subgroup), known TR4-susceptible cultivar
- **Planting Material:** Tissue-cultured seedlings to ensure zero initial contamination
- **Planting Date:** September 14, 2023
- **Plant Spacing:** 2.17 × 2.2 m (2,000 plants/hectare, following commercial practices)

The selection of an abandoned plantation with established TR4 infestation provided the most challenging and realistic testing environment, representing worst-case field conditions.

4.4 Results

4.4.1 Preventive Treatment Results

Plant treatment did result in substantial reduction in TR4 infection rates across two complete harvest cycles:

- **Disease Reduction: 40%**
    - **Control Group: 100% infection rate**
    - **ECP Treated Plants: 60% infection rate**

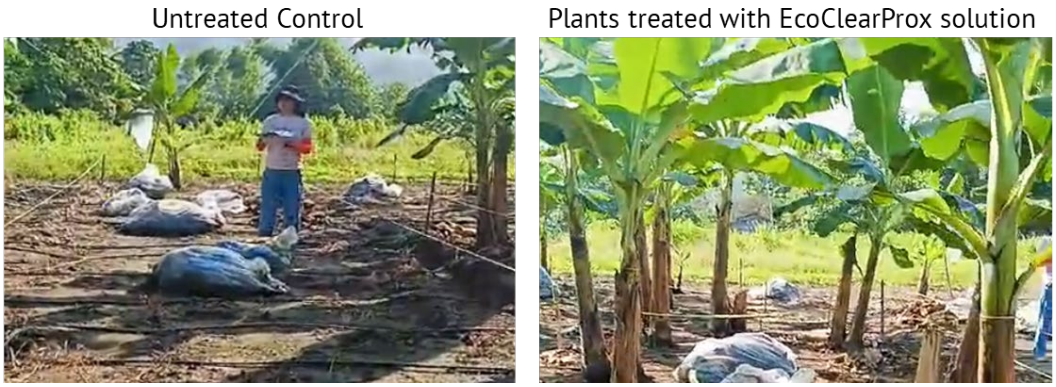


Figure 2: Comparison of Control Group and Treated Plants

Beyond disease control, ECP treatment provided additional agricultural benefits:

- ECP treatment shows promise for optimizing banana yields, balancing gross bunch weight, hand weight, and maintaining good number of functional leaves at harvest

- ECP treatments resulted in shorter maturation period (9 weeks) compared to the Untreated Control (10 weeks).

- Finger length was stable at 10 inches across all treatments, indicating that ECP concentration did not affect fruit elongation

4.4.2 Curative Treatment Results

While primarily designed as a preventive treatment, ECP showed promising curative potential:

- 24 infected plants demonstrated visible symptom improvement
- Disease progression resumed following standard monthly treatment

The results suggest higher treatment frequencies may enhance curative or suppressive efficacy, providing a foundation for curative/ suppressive protocol development.

5 Discussion and Comparative Analysis

5.1 Current TR4 Management Landscape

Understanding the existing limitations in managing *Fusarium wilt Tropical Race 4* (TR4) is crucial for evaluating the potential impact of novel therapeutic approaches. The current management paradigm reveals significant gaps that underscore the urgent need for innovative solutions.

5.1.1 Aavailable Management Strategies

- **Resistant Cultivars:** While genetic resistance represents the most promising long-term strategy, the commercial pipeline remains severely constrained. Few cultivars combine adequate TR4 resistance with the agronomic performance and market characteristics demanded by commercial producers. Recent breakthroughs demonstrate progress, but widespread adoption remains years away.
- **Biological Control:** Despite extensive research into antagonistic microorganisms, biocontrol agents exhibit highly variable performance across different environmental conditions and soil types. Laboratory efficacy rarely translates to consistent field results, limiting practical implementation in commercial settings.
- **Cultural Management:** Current practices emphasize strict quarantine protocols, equipment sanitization, and movement restrictions. While these measures can slow disease spread, they offer no solution once soil contamination occurs and fail to restore productivity to infected areas.
- **Chemical Intervention:** The absence of registered fungicides with proven TR4 efficacy represents a critical gap in the management toolkit. Unlike many other plant pathogens, TR4's soil-borne nature and persistence make it particularly recalcitrant to conventional chemical control strategies.

5.1.2 Critical Management Deficiencies

- **Therapeutic Void:** The most significant limitation lies in the complete absence of curative treatments. Once TR4 establishes in soil, no commercially available interventions can eliminate the pathogen or restore plant health to infected crops.

- **Vulnerable High-Value Production**: Premium banana varieties that drive commercial profitability typically lack meaningful TR4 resistance. This creates an untenable situation where the most economically important cultivars remain the most vulnerable to devastating losses.
- **Irrigation System Contamination:** Waterborne transmission through irrigation networks represents a particularly insidious challenge. Existing disinfection protocols prove inadequate for complex irrigation systems, allowing rapid disease dissemination across previously uninfected areas.

The convergence of these limitations creates a management landscape where prevention remains the only viable strategy, leaving producers with few options once TR4 breaches their defenses.

5.2 ECP Comparative Advantages

5.2.1 Multi-Modal Efficacy

Unlike single-approach solutions, ECP demonstrates:

- Preventive field protection (40% disease reduction)
- Water source sanitization (100% spore elimination)
- Yield enhancement and growth promotion
- Potential curative applications

5.2.2 Practical Implementation

- Monthly application frequency aligns with commercial farming practices
- Compatible with existing irrigation infrastructure

5.2.3 Economic Viability

- Yield increases and earlier harvest offset partially treatment costs
- Reduces crop loss risk in TR4-affected regions
- Enables continued cultivation of preferred commercial varieties

6 Implications for TR4 Management

6.1 Regional Disease Control Strategy

ECP offers potential for integrated regional TR4 management:

Water System Protection:

- Treatment of irrigation networks and water sources
- Prevention of inter-farm transmission
- Protection of TR4-free areas

Field-Level Integration:

- Combination with cultural practices and resistant varieties
- Enhanced protection for susceptible commercial cultivars
- Potential for curative treatment protocol development

6.2 Global Application Potential

The technology addresses key challenges across major banana-producing regions:

- **Affected Areas:** Established TR4 regions requiring damage mitigation
- **At-Risk Areas:** Prevention of TR4 introduction and establishment
- **Commercial Operations:** Protection of high-value commercial varieties

7 Conclusions

This comprehensive field trial demonstrates that EcoClearProx represents a significant advancement in TR4 management technology. The combination of substantial disease reduction, yield enhancement, accelerated harvest timing, and complete water-borne spore elimination addresses multiple critical aspects of TR4 control.

Key Strengths:

- Sustained efficacy across two harvest cycles
- Multi-modal approach addressing soil and water transmission
- Economic benefits beyond disease control
- Compatibility with existing agricultural practices

Commercial Implications:

- Enables continued cultivation in TR4-affected areas
- Provides protection for susceptible commercial varieties
- Offers integrated solution for regional disease management

The results position EcoClearProx as a key solution capable of transforming TR4 management from reactive containment to proactive, integrated disease control. This represents a critical advancement for the global banana industry facing the ongoing TR4 pandemic.

About us

TMRW Eco is a cutting-edge company specializing in eco-friendly biocides for a wide range of industries. Our flagship product is a 100% biodegradable hydrogen peroxide solution that delivers powerful disinfection results without relying on harmful stabilizing additives like silver.

We cater to industries including agriculture, live-stock farming, and water treatment, and understand the importance of providing safe and effective alternatives to traditional biocides. Our customers trust us to provide solutions that are not only effective, but also prioritize the health of the environment.

We differentiate ourselves by our unwavering commitment to sustainability and our passion for developing innovative biocides that leave a positive impact.

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