Nano-mediated rapid detection and biocontrol of downy and powdery mildew of grapes and powdery mildew of tomatoes

Brief Report

An integrated nanotechnology-based strategy was developed for the early detection and effective biocontrol of major fungal pathogens affecting grapes and tomatoes. Gold nanoparticle-based DNA detection assays were designed for *Plasmopara viticola* and *Erysiphe necator* (causing downy and powdery mildew in grapes) and *Leveilulla taurica* (causing powdery mildew in tomatoes). These assays are field-usable, specific, rapid, and visually interpretable, enabling early pathogen detection directly at the site of infection without the need for sophisticated laboratory infrastructure. This real-time diagnostic capability empowers farmers to take timely disease management decisions, preventing crop losses.

In parallel, a biocompatible nanoformulation comprising mycolytic enzymes was developed for sustainable disease control. This formulation targets fungal cell walls and is effective against both ascomycete and oomycete pathogens. Encapsulation in natural, biodegradable polymers enhances enzyme stability and field applicability. The formulation offers an environmentally friendly alternative to synthetic fungicides, reducing chemical input while maintaining crop health and productivity.

Together, these innovations represent a robust, eco-conscious approach to disease management in grapes and tomatoes. The combined use of rapid diagnostics and sustainable biocontrol can significantly improve disease outcomes, enhance fruit quality, and contribute to safer, residue-free agricultural produce suitable for domestic and export markets.

Integrated Approach for Disease Management
- The combination of rapid detection assays and biocontrol nanoformulation represents a novel, holistic strategy for managing fungal diseases in grapevines and tomato crops.
- The integrated approach will enhance disease management, reduce crop losses, and help maintain the quality of tomato fruits, table grapes, and wine.

Impact on Forecasting and Fungicide Use
- Early and precise detection of fungal pathogens will not only improve immediate disease control but also contribute valuable data to refine forecasting models, helping to optimize the timing and necessity of fungicide applications.