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Editorial

Biological Control of White Root Rot Disease Caused by *Rosellinia necatrix*: Harnessing Microbial Strategies for Sustainable Crop Protection

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White root rot disease, caused by the soil-borne ascomycete *Rosellinia necatrix*, remains one of the most destructive and persistent threats to perennial crops such as pear, apple, citrus, tea, and avocado. The pathogen invades the root cortex and woody tissues, leading to extensive decay, nutrient deprivation, and ultimately plant death. Its long-term survival in soil through resistant mycelia and sclerotia makes eradication extremely difficult once the disease is established in orchards. As a result, *R. necatrix* continues to cause severe yield losses worldwide, particularly in temperate fruit-growing regions.

Challenges and the shift toward sustainable management

Conventional disease management relies on the removal of infected trees, soil fumigation, and chemical fungicides, yet these approaches are costly, environmentally detrimental, and often ineffective against deep-rooted infections. The limited success of such methods has motivated the exploration of sustainable, biologically based strategies for disease suppression.

Over the past few years, my research group has focused on developing microbial biocontrol strategies targeting *R. necatrix.* Our work has demonstrated the strong antagonistic potential of Trichoderma and *Bacillus* species as eco-friendly alternatives to chemical control. In a recent study, we evaluated several Trichoderma isolates and confirmed their ability to suppress R. necatrix through multiple mechanisms, including mycoparasitism, hydrolytic enzyme secretion, and induced systemic resistance in pear roots (Sawant et al., 2024). Similarly, our investigations on *Bacillus velezensis* strains S41L and RDA1 revealed their efficiency in inhibiting pathogen growth and improving root health under greenhouse conditions (Sawant et al., 2022; 2023). These findings emphasize that both fungal and bacterial antagonists hold significant promise as biological control agents for sustainable orchard management.

Mechanisms underpinning microbial suppression

The antagonistic action of these beneficial microbes is multifaceted. Trichoderma spp. colonize the rhizosphere aggressively and compete with R. necatrix for space and nutrients, while also producing cell wall–degrading enzymes such as chitinases and β-1,3-glucanases that directly attack the pathogen. *Bacillus* spp. contribute through the secretion of antifungal lipopeptides, siderophores, and volatile organic compounds that inhibit pathogen development while stimulating plant defense responses. The ability of *B. velezensis* strains to form endospores also ensures stability and persistence in the rhizosphere, enhancing their suitability for field application.

Toward integrated biological management

Despite encouraging laboratory and greenhouse results, field-level implementation remains challenging due to variations in soil composition, microbial competition, and environmental conditions. A holistic approach combining compatible microbial consortia, organic amendments, and soil health restoration practices may provide durable disease control. In our earlier review (Sawant et al., 2021, Research in Plant Disease), we highlighted the importance of integrating biological agents with orchard management strategies to achieve long-term suppression of white root rot. Future studies employing metagenomic and metabolomic tools could further unravel the complex interactions among pathogens, host plants, and beneficial microbes, ultimately leading to the formulation of more reliable microbial products.

Concluding Perspective

The biological control of *Rosellinia necatrix* is not merely an academic pursuit but a crucial step toward sustainable agriculture. Harnessing beneficial microorganisms such as Trichoderma and *Bacillus* offers a viable path to minimize chemical inputs, enhance soil health, and maintain productive orchard ecosystems. Continued interdisciplinary research integrating plant pathology, microbial ecology, and bioprocess engineering will accelerate the translation of biocontrol discoveries into practical field applications. As our understanding deepens, biological solutions can become the foundation of resilient and environmentally responsible crop protection systems.

Keywords: *Rosellinia necatrix*, white root rot, Trichoderma, *Bacillus velezensis*, biological control, sustainable agriculture.

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