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Efficacy of Trichoderma spp. and *Pseudomonas fluorescens* against Soil-Borne Pathogens in Groundnut

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Abstract

Groundnut (Arachis hypogaea L.) is an important oilseed and food legume crop cultivated widely in tropical and subtropical regions. However, its productivity is significantly constrained by soil-borne pathogens such as Sclerotium rolfsii, Rhizoctonia solani, Aspergillus niger, and Fusarium spp., which cause collar rot, stem rot, root rot, and seedling blight. Chemical fungicides have traditionally been used to manage these diseases, but their continuous application has led to environmental concerns, pathogen resistance, and high production costs. Biological control using antagonistic microorganisms such as Trichoderma spp. and Pseudomonas fluorescens has emerged as a sustainable and eco-friendly alternative. This popular article reviews the efficacy, mechanisms of action, and practical applications of these bioagents in managing soil-borne diseases of groundnut.

Keywords: *Groundnut, Arachis hypogaea, Trichoderma, Pseudomonas fluorescens, soil-borne pathogens, biological control.*

Introduction

Groundnut (*Arachis hypogaea*) plays a crucial role in global agriculture as a source of edible oil, protein, and animal feed. It is particularly important for smallholder farmers in developing countries due to its adaptability to diverse agro-climatic conditions. Despite its economic value, groundnut production faces severe losses due to soil-borne fungal pathogens that infect seeds, roots, and stems [1]. Soil-borne diseases such as stem rot caused by *Sclerotium rolfsii*, root rot caused by *Rhizoctonia solani*, and wilt caused by *Fusarium* spp. are persistent and difficult to control because the pathogens survive in soil through resistant structures such as sclerotia and chlamydospores. Integrated disease management strategies increasingly emphasize biological control agents, particularly *Trichoderma* spp. and *Pseudomonas fluorescens*, due to their proven antagonistic activity and plant growth–promoting effects.

Major Soil-Borne Pathogens of Groundnut

Groundnut is vulnerable to several destructive soil-borne pathogens. *Sclerotium rolfsii* causes stem rot characterized by white mycelial growth and mustard-like sclerotia at the collar region. *Rhizoctonia solani* induces seedling blight and root rot, leading to poor crop stand. Species of *Fusarium* cause vascular wilt and root rot, resulting in yellowing and stunted growth. Additionally, *Aspergillus niger* contributes to seedling diseases and may contaminate kernels. These pathogens persist in soil for long periods and spread through contaminated soil, irrigation water, and infected plant debris, making management challenging [2].

Table 1. Mechanisms and Effects of Trichoderma spp. and Pseudomonas fluorescens against Major Soil-Borne Pathogens of Groundnut

Bioagent	Major Mechanisms of Action	Target Pathogens in Groundnut	Observed Effects
Trichoderma spp.	Mycoparasitism, production of chitinases & glucanases, antibiosis, competition for nutrients, induced systemic resistance	*Sclerotium rolfsii*, *Rhizoctonia solani*, *Fusarium* spp., *Aspergillus niger*	Reduced disease incidence, improved seed germination, enhanced plant vigor and yield
Pseudomonas fluorescens	Antibiotic production (phenazines, pyoluteorin), siderophore production, hydrogen cyanide secretion, induced systemic resistance	*Sclerotium rolfsii*, *Rhizoctonia solani*, *Fusarium* spp.	Suppressed pathogen growth, improved root development, increased nodulation and yield
Combined Application	Synergistic action (direct antagonism + plant defense stimulation)	Broad-spectrum soil-borne pathogens	Greater disease reduction and yield improvement compared to single bioagent

Role of *Trichoderma* spp. in Disease Suppression

Species of *Trichoderma* are among the most widely studied fungal bioagents for controlling soil-borne pathogens. Common species used in agriculture include *Trichoderma harzianum*, *Trichoderma viride*, and *Trichoderma asperellum*. These fungi colonize the rhizosphere effectively and compete with pathogens for nutrients and space. The mechanisms by which *Trichoderma* suppresses pathogens include mycoparasitism, antibiosis, competition, and induction of systemic resistance in plants.

During mycoparasitism, *Trichoderma* coils around the hyphae of pathogenic fungi and secretes lytic enzymes such as chitinases, glucanases, and proteases, leading to pathogen cell wall degradation, it produces secondary metabolites with antifungal properties [3]. Field and greenhouse studies have demonstrated that seed treatment and soil application of *Trichoderma* formulations significantly reduce disease incidence of stem rot and root rot in groundnut while improving seed germination, plant vigor, and yield.

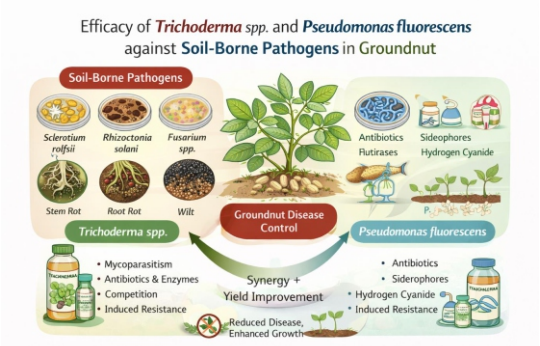

Fig 1: Efficacy of Trichoderma and Pseudomonas against soil borne pathogens

Role of *Pseudomonas fluorescens* in Disease Management

Pseudomonas fluorescens is a plant growth–promoting rhizobacterium (PGPR) widely used in biological disease control. It colonizes the root surface and rhizosphere, forming a protective barrier against soil-borne pathogens. The antagonistic mechanisms of *Pseudomonas fluorescens* include production of antibiotics such as phenazines and pyoluteorin, secretion of siderophores that sequester iron, hydrogen cyanide production, and induction of systemic resistance in host plants. These mechanisms inhibit pathogen growth and enhance plant defense responses [4]. Application of *Pseudomonas fluorescens* as seed treatment or soil drench has been reported to significantly reduce incidence of collar rot and wilt in groundnut. Moreover, treated plants often exhibit enhanced root development, nodulation, and overall growth.

Combined Application and Synergistic Effects

The combined use of *Trichoderma* spp. and *Pseudomonas fluorescens* often results in synergistic effects, providing broader-spectrum disease control. While *Trichoderma* primarily targets fungal pathogens through direct parasitism, *Pseudomonas* enhances plant defense and suppresses pathogens through antibiotic production and competitive exclusion. Integrated application methods include seed treatment, soil amendment with enriched compost, and root dipping before transplantation. Studies indicate that combined bioagent application can significantly reduce pathogen populations in soil and improve pod yield compared to single-agent treatments [5].

Advantages over Chemical Control

Biological control using *Trichoderma* spp. and *Pseudomonas fluorescens* offers several advantages over conventional fungicides. These include environmental safety, reduced risk of resistance development, compatibility with organic farming systems, and enhancement of soil health. Bioagents also improve nutrient availability and stimulate plant growth, contributing to sustainable crop production. However, field performance may vary depending on environmental conditions, soil type, formulation quality, and application methods [6]. Therefore, proper strain selection and formulation technology are essential for consistent results.

Challenges and Future Prospects

Despite promising results, challenges remain in large-scale adoption of bioagents. Variability in field efficacy, limited shelf life of formulations, and lack of farmer awareness hinder widespread use. Advances in formulation technology, such as encapsulation and carrier-based delivery systems, are improving stability and effectiveness [7]. Future research should focus on molecular characterization of effective strains, understanding rhizosphere interactions, and developing consortium-based bioformulations. Integration of bioagents with other sustainable agricultural practices will further strengthen disease management strategies in groundnut.

Conclusion

Soil-borne pathogens pose a major threat to groundnut production worldwide. Biological control using *Trichoderma* spp. and *Pseudomonas fluorescens* offers an effective, eco-friendly, and sustainable approach to managing these diseases. Their multifaceted mechanisms—including mycoparasitism, antibiosis, competition, and induction of systemic resistance—contribute to significant disease suppression and enhanced plant growth. The application of these bioagents holds great potential for integrated disease management programs aimed at improving groundnut productivity while reducing dependence on chemical fungicides.

References

1. Harman, G. E., Howell, C. R., Viterbo, A., Chet, I., & Lorito, M. (2004). *Trichoderma* species—opportunistic, avirulent plant symbionts. Nature Reviews Microbiology, 2(1), 43–56.
2. Haas, D., & Défago, G. (2005). Biological control of soil-borne pathogens by fluorescent pseudomonads. Nature Reviews Microbiology, 3(4), 307–319.
3. Howell, C. R. (2003). Mechanisms employed by *Trichoderma* species in the biological control of plant diseases: The history and evolution of current concepts. Plant Disease, 87(1), 4–10.
4. Weller, D. M. (2007). *Pseudomonas fluorescens*: A plant-growth-promoting rhizobacterium and biological control agent. Phytopathology, 97(2), 250–256.
5. Lorito, M., Woo, S. L., Harman, G. E., & Monte, E. (2010). Translational research on *Trichoderma*: From laboratory to field. Annual Review of Phytopathology, 48, 395–417.
6. Raaijmakers, J. M., Vlami, M., & de Souza, J. T. (2002). Antibiotic production by bacterial biocontrol agents. Antonie van Leeuwenhoek, 81, 537–547.
7. Beneduzi, A., Ambrosini, A., & Passaglia, L. M. P. (2012). Plant growth-promoting rhizobacteria (PGPR): Their potential as antagonists and growth promoters. Genetics and Molecular Biology, 35(4), 1044–1051.