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Trichoderma: A Promising Plant Disease Control Tool

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In traditional crop cultivation, excessive pesticide and chemical fertilizer use, along with extensive single-crop planting, have severely damaged farmland ecosystems. This has resulted in plant diseases, pest infestations, pesticide residues in crops, and pollution of soil and water environments. With the push for environmentally conscious agriculture, there's a pressing need for safe and eco-friendly methods to control plant diseases. Biological control, employing beneficial organisms, is a key approach to combatting these issues (Harman *et al*., 2021). The rhizosphere is a bustling hub for a diverse microbial community, housing a variety of inhabitants such as saprophytes, epiphytes, endophytes, pathogens, and numerous beneficial microorganisms. While bacteria dominate this microbial population, fungi, actinomycetes, protozoa, and algae also thrive in this environment. These include *Azospirillum*, *Bacillus*, *Flavobacterium*, *Mesorhizobium*, *Pseudomonas*, *Rhizobium*, *Beauveria*, *Metarhizium*, *Trichoderma*, *Verticillium* species etc actively participate in combatting pathogens and insects.

Trichoderma, a widely utilized biological fungus for disease management in plants, thrives in soil, air, and on plant surfaces. It's remarkably effective against various plant diseases (Wang *et al*., 2022). Mainly targeting soil-borne diseases and some aerial diseases, *Trichoderma* not only prevents diseases but also fosters plant growth, enhances nutrient utilization, boosts plant resilience, and aids in reversing agrochemical pollution (Fontana *et al*., 2021).

Advantages of Biocontrol Agents

1. Cost-Effective: Biological control proves to be a more economical method compared to others.
2. Non-Toxic: They do not induce toxicity in plants and environment.
3. Safe Application: Applying biocontrol agents is safer for both the environment and the individuals using them.
4. Minimal Residual Impact: They easily proliferate in the soil and leave no lasting residue.
5. Growth Enhancement: Biocontrol agents not only combat diseases but also stimulate beneficial soil microorganisms, promoting root and plant growth and ultimately increasing crop yields.
6. Compatibility: Biocontrol agents can be combined with bio-fertilizers and other agricultural chemicals.

Mode of Action of Biocontrol Agents

Biocontrol agents use various mechanisms in plant disease control thus safeguarding host plants against invading pathogen. This includes:

Competition: Microorganisms compete for space, minerals and organic nutrients in their natural environment. This competitive dynamic of *Trichoderma* has been linked to the biocontrol of *Fusarium* and *Pythium* species.

Antibiosis: This involves antagonism mediated by specific or nonspecific metabolites of microbial origin, lytic agents, enzymes, volatile compounds, or other toxic substances. Crucial in biological control, it occurs when metabolites secreted by underground plant parts, soil microorganisms, or plant residues inhibit or kill pathogens.

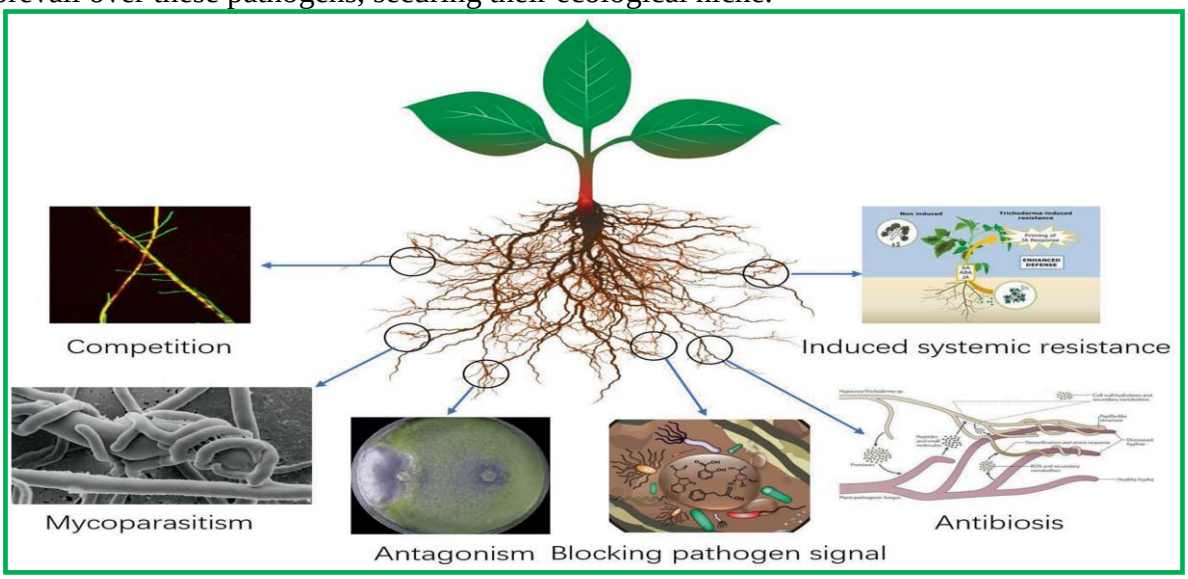
Mycoparasitism/Hyperparasitism: The antagonist inhibits or kills pathogens by secreting enzymes like chitinases, cellulases, glucanases, and other lytic enzymes. Mycoparasitism depicts one fungus parasitizing another, with the parasitic fungus termed the hyperparasite and the victimized one termed as the hypoparasite. Various mechanisms operate in mycoparasitism, including hyphal interactions resulting in predation such as coiling, penetration, branching, sporulation, resting body production, barrier formation and cell lysis.

Lytic Enzymes: Lysis (the breakdown of a cell) occurs either by the cell's own enzymes after death (endolysis) or by enzymes from another organism (exolysis). Exolysis typically involves the destruction of cell walls by enzymes like chitinases and cellulases, often leading to parasitic cell death.

Hydrogen Cyanide: Many rhizobacteria produce hydrogen cyanide, which directly and indirectly aids in biological control of plant diseases by suppressing pathogens and enhancing yields.

Induced Systemic Resistance (ISR): ISR induces plant defense mechanisms against pathogens. Inoculating plants with weak pathogens triggers systemic resistance against subsequent challenges. This resistance, effective against various pathogens for several weeks, reinforces cell wall strength and prompts the synthesis of defense chemicals like PR proteins, chitinase, glucanase, phytoalexins, and phenolics.

Root colonization: The effectiveness of biocontrol agents in antagonism hinges upon their ability to colonize roots. Root colonization stands as the pivotal process for these bacteria, involving their adherence to roots or penetration into the root interior, followed by residing around or within the roots. This colonization relies on continuous communication between plants and microbes. Plants release root exudates, which rhizosphere bacteria utilize to establish their presence around the roots. These exudates are also utilized by pathogens in the root vicinity. Nonetheless, due to intense competition, beneficial rhizosphere microorganisms prevail over these pathogens, securing their ecological niche.



Schematic diagram of the mechanism of action of *Trichoderma* in plant fungal disease control

Conclusion

The evolution of agricultural production faces a series of new hurdles, posing a crucial requirement to address these challenges promptly and effectively. Many nations, including India, have witnessed agricultural growth leveling off due to the limitations of modern farming techniques. Simultaneously, the excessive use of chemical fertilizers and pesticides has raised significant environmental concerns. Embracing biological control emerges as a potential alternative system, offering a pivotal role in steering agriculture towards its goals.

References

1. Wang, Y., Chen, H., Ma, L., Gong, M., Wu, Y. and Bao, D. (2022). Use of CRISPR-Cas tools to engineer *Trichoderma* species. *Microb. Biotechnol*. **15**, 2521–2532.
2. Harman, G., Khadka, R., Doni, F. and Uphoff, N. (2021). Benefits to plant health and productivity from enhancing plant microbial symbionts. *Front. Plant Sci*. **11**, 1-21.
3. Fontana, D. C., de Paula, S., Torres, A. G., de Souza, V., Pascholati, S. F. and Schmidt, D. (2021). Endophytic fungi: biological control and induced resistance to phytopathogens and abiotic stresses. *Pathogens*. **10**, 570.
4. Slavica, G. and Brankica, T. (2013). Biopesticide formulations, possibility of application and future trends. *Pestic. Fitomed*. **28**(2), 97–102.
5. Mohanram, S. and Kumar, P. (2019). Rhizosphere microbiome: Revisiting the synergy of plant-microbe interactions. *Ann. Microbiol*. **69**(4), 307–320.
6. Björkman, T., Blanchard, L.M. and Harman, G.E. (1998). Growth enhancement of shrunken-2 sweet corn by *Trichoderma harzianum* 1295–22: effect of environmental stress. *J. Am. Horti. Soc*. **123**, 35–40.