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The Study of Compatibility of *Trichoderma harzianum* with Fungicide (Captan) using Poisoned Food Technique

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Abstract

Trichoderma harzianum, a well-known biocontrol agent, has shown remarkable potential in controlling various plant pathogenic fungi. However, the efficacy of *Trichoderma*-based biofungicides can be influenced by the presence of chemical fungicides in the environment. The present study aimed to assess the compatibility of *Trichoderma harzianum* with the widely used synthetic fungicide, captan using the Poisoned Food Technique. The Poisoned Food Technique is a reliable method for investigating the potential antagonistic effects between biocontrol agents and chemical fungicides. In this study, varying concentrations of 60% captan fungicide were incorporated into a growth medium used for cultivating *Trichoderma harzianum*. The bioassays were conducted in a controlled laboratory setting. The results revealed that the compatibility of *Trichoderma harzianum* with 60%% captan fungicide was maximum at 800 ppm followed by 400 ppm, 600 ppm and 1000 ppm. Least compatibility was seen at 200 ppm. In conclusion, this study provides valuable insights into the compatibility of *Trichoderma harzianum* with 60% captan fungicide. The findings highlight the importance of understanding the interaction between biocontrol agents and chemical fungicides to maximize disease management efficiency while minimizing any potential negative impacts on beneficial microorganisms. These results contribute to the development of sustainable and effective agricultural practices that harness the synergistic potential of both biocontrol agents and chemical fungicides.

Keywords: Biocontrol agent, Captan, Fungicide, Integrated disease management, Poisoned Food Technique, Sustainable agriculture, *Trichoderma harzianum*.

Introduction

Biocontrols, also known as biological control or biopesticides, refer to the use of natural organisms or their by-products to manage pests, diseases, and invasive species in agriculture and other ecosystems.[1,2,3] Unlike conventional chemical pesticides, biocontrols offer an eco-friendly and sustainable approach, minimizing environmental and health risks. These biocontrols include beneficial insects, nematodes, fungi, bacteria, and viruses that target specific pests, disrupting their life cycles or causing mortality. By harnessing the power of nature's own checks and balances, biocontrols provide an effective and long-term solution to

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pest management, promoting biodiversity and ensuring the health and resilience of ecosystems and crops alike.[4,5,6]

Trichoderma harzianum, a naturally occurring biocontrol fungus, has gained significant attention for its potential in controlling various plant pathogens.[7] *Trichoderma harzianum* is a well-known and extensively studied biocontrol agent that plays a vital role in sustainable agriculture and environmental protection. As a naturally occurring fungus, it exhibits remarkable biocontrol properties against various plant pathogens, making it a valuable tool for integrated pest management (IPM) strategies. One of the key biocontrol mechanisms employed by *Trichoderma harzianum* is its antagonistic activity. It competes with plant pathogens for space and nutrients, thereby suppressing their growth and development.[8] The fungus also produces a range of secondary metabolites, such as chitinases, glucanases, and proteases, which have the ability to directly degrade the cell walls and components of pathogenic organisms. This enzymatic degradation weakens the pathogens, leading to their eventual collapse. Furthermore, *Trichoderma harzianum* has been found to induce systemic resistance in plants. When the fungus colonizes the plant roots, it triggers a systemic response, stimulating the plant's natural defense mechanisms. This induced resistance not only protects the host plant against the specific pathogens but also enhances its overall resistance to various stresses. The biocontrol property of *Trichoderma harzianum* is environmentally friendly and sustainable, as it reduces the reliance on chemical pesticides, thereby minimizing potential adverse effects on non-target organisms and the ecosystem. Moreover, this biocontrol agent is easy to apply, compatible with other control methods, and shows long-term effectiveness. *Trichoderma harzianum* stands as a powerful biocontrol agent that offers a promising alternative for managing plant diseases while promoting ecological balance in agriculture. Its ability to antagonize pathogens and induce systemic resistance in plants makes it an invaluable asset in the pursuit of sustainable and eco-friendly agricultural practices.[9,10]

Captan fungicide is a widely used agricultural chemical with potent fungicidal properties. It belongs to the phthalimide class of fungicides and is renowned for its broad-spectrum efficacy against various fungal diseases that afflict crops. Captan acts by inhibiting fungal cell division and disrupting cellular respiration, thus effectively controlling the spread of infections. Its versatility makes it valuable for a wide range of crops, including fruits, vegetables, and ornamentals. Farmers and horticulturists favor captan for its reliable disease management and low risk of resistance development. However, its usage requires careful consideration of safety precautions, as captan is moderately toxic to humans and wildlife, necessitating responsible application practices and adherence to recommended guidelines.[11,12,13] The objective of the present study is to investigate the potential interaction between the biocontrol agent *Trichoderma harzianum* and the chemical fungicide captan when they are both present in the same environment and determining the minimum inhibitory concentration (MIC) of Captan that affects *Trichoderma harzianum*'s growth

Materials and Methods

Sample collection

- *Trichoderma harzianum* Isolate

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A standard laboratory strain of *Trichoderma harzianum* was obtained from Microbiology laboratory, Department of Botany, Maharani Cluster University, Bengaluru, Karnataka, India. The strain was maintained on Potato Dextrose Agar (PDA) medium and stored at 4°C.

- Captan Fungicide

A commercial formulation of captan fungicide containing 60% active ingredient was collected from local market, Bengaluru.

Poisoned Food Technique

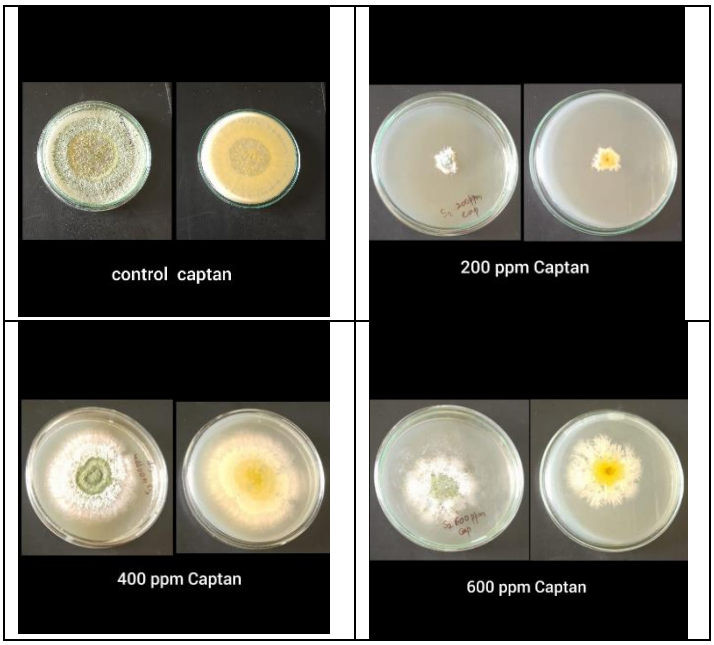
The Poisoned Food Technique was employed to assess the compatibility of *Trichoderma harzianum* with captan. Different Concentrations of 60% captan were incorporated in the media viz., 200 ppm, 400 ppm, 600 ppm, 800 ppm and 1000 ppm. PDA plates supplemented with various concentrations of captan were prepared. Control plates containing only PDA were also set up. Experiments were performed in triplicates and the results produced in the present paper is the average of the triplicates. The plates were incubated at an optimal temperature for *Trichoderma harzianum* growth (typically 25-30°C) for 7 days.

Evaluation Parameters

The compatibility study was based on the following parameters:

a) Growth Inhibition: The radial growth of *Trichoderma harzianum* was measured from the edge of the colony to the hyphal front in each plate.

b) Compatibility: The ability of *Trichoderma harzianum* to grow in the captan containing media was evaluated.



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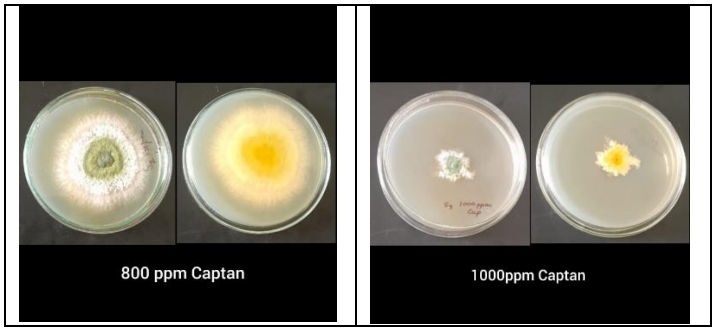

Fig 1: Compatibility of *Trichoderma harzianum* with Captan

Results

The results revealed that the compatibility of *Trichoderma harzianum* with 60% captan fungicide was maximum at 800 ppm followed by 400 ppm, 600 ppm and 1000 ppm. Least compatibility was seen at 200 ppm.

Table 1: Compatibility of *Trichoderma harzianum* with Captan

Fungicides	Concentration	Zone of inhibition (mm)	Mean colony diameter (mm)
Control	00 ppm	00	90
Captan 60%	200 ppm	83	07
Captan 60%	400 ppm	48.3	41.7
Captan 60%	600 ppm	20	70
Captan 60%	800 ppm	23.3	66.7
Captan 60%	1000 ppm	74	16

Discussion

The compatibility study using the Poisoned Food Technique demonstrated that *Trichoderma harzianum* and 60% captan can be used together effectively for disease management. *Trichoderma harzianum* showed sensitivity to captan at certain tested concentrations while the other concentrations didn't affect the growth of *Trichoderma harzianum* much. The lack of growth inhibition in *Trichoderma harzianum* suggests that the biocontrol agent can thrive in captan-treated environments. This finding indicates that *Trichoderma harzianum* can be integrated into IPM programs alongside captan applications to enhance disease management and potentially reduce the reliance on chemical fungicides.

Bhale, Udhav et al., had studied the compatibility of fungicides viz. Mancozeb and Captan with *Trichoderma spp* (*T. viride, T. harzianum, T. koningii, T. pseudokoningii* and *T. virens*) at different concentrations. It was indicated that lower concentrations of Mancozeb and Captan did not affect the radial growth of *Trichoderma spp*. However, concentration of Mancozeb above 5000 µg/ml and of Captan above 500 µg/ml significantly reduced the radial growth of *Trichoderma spp*. *Trichoderma viride, T. harzianum, T. virens* and *T. koningii*.[14] These results are partially similar and partially in contrast with our result where compatibility of *Trichoderma harzianum* with 60% captan fungicide was maximum at 800 ppm followed by 400 ppm, 600 ppm and 1000 ppm. Least compatibility was seen at 200 ppm. Amoghavarsha Chittaragi et al., had studied the compatibility of *Trichoderma asperellum* with captan fungicide. Results

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revealed that *Trichoderma asperellum* was not compatible with captan.[15] These results are in contrast with our results where *Trichoderma harzianum* is compatible with captan. G. Bindu Madhavi et al., had studied the compatibility of *Trichoderma viride* with contact fungicides viz., pencycuron and propineb. Results revealed that *Trichoderma viride* was compatible with pencycuron and propineb.[16] Similarly, in the present study *Trichoderma harzianum* was compatible with captan.

Conclusion

The study concludes that *Trichoderma harzianum* is compatible with 60% captan fungicide as evaluated by the Poisoned Food Technique. The biocontrol agent retained its growth and biocontrol efficacy in the presence of captan. Integrating *Trichoderma harzianum* with captan applications in IPM strategies can provide an effective and sustainable approach for disease control in agriculture.

Future Directions

Further research is recommended to explore the compatibility of *Trichoderma harzianum* with other fungicides and agrochemicals commonly used in agriculture. Additionally, field trials should be conducted to validate the compatibility findings under practical farming conditions. Long-term studies on the combined effects of *Trichoderma harzianum* and captan on crop growth and yield would provide a comprehensive understanding of their collective impact on agricultural sustainability.

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