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Study of Compatibility between *Trichoderma harzianum* and Carbendazim Fungicide using Poisoned Food Technique

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Abstract

Trichoderma harzianum is a well-known biocontrol agent widely utilized for its antagonistic properties against various plant pathogens. Carbendazim is a synthetic fungicide commonly used in agricultural practices to control fungal diseases. To ensure sustainable and effective disease management strategies, it is crucial to assess the compatibility of these two agents when used together. The present study aims to evaluate the compatibility of *Trichoderma harzianum* with different concentrations Carbendazim fungicide viz., 200 ppm, 400 ppm, 600 ppm, 800 ppm and 1000 ppm using the poisoned food technique. The findings of the present study will contribute to understanding of potential synergistic or antagonistic effects of combining biocontrol agents and synthetic fungicides for enhanced disease control in agriculture.

Keywords: Antagonism, Biocontrol agent, Carbendazim, Fungicide, Synergistic effect, *Trichoderma harzianum*

Introduction

Fungal infections in plants, known as plant pathogenic fungi, pose a significant threat to global agriculture and natural ecosystems. These microscopic organisms can invade various plant parts, such as leaves, stems, and roots, causing diseases like rusts, blights, and wilts. Fungal pathogens thrive in warm, moist conditions, spreading through spores and contaminated soil. Symptoms include discoloration, lesions, stunted growth, and eventual death. To manage fungal infections, farmers employ cultural practices, such as crop rotation, and use fungicides sparingly. Additionally, breeding resistant plant varieties and promoting overall plant health through proper watering and nutrient management are crucial in combating these destructive pathogens.[1,2,3]

Carbendazim is a fungicide widely used in agriculture to combat fungal diseases in various crops. Its chemical composition consists of a benzimidazole group combined with a methyl carbamate moiety. The chemical formula is C9H9N3O2, and its molecular weight is approximately 191.2 g/mol. The molecular structure of carbendazim includes a benzene ring

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linked to an imidazole ring, with a carbamate group attached to the imidazole nitrogen. This unique structure is essential for its antifungal activity. Carbendazim's mode of action involves disrupting fungal cell division and interfering with microtubule assembly, which is crucial for maintaining the structural integrity of the fungal cells during mitosis. The fungicide inhibits an enzyme called beta-tubulin, which is responsible for polymerizing tubulin and forming microtubules. As a result, the growth and replication of the fungal cells are inhibited, leading to the suppression of fungal infections. Carbendazim is considered a systemic fungicide, meaning it can penetrate plant tissues and protect them from internal fungal infections. It exhibits broad-spectrum activity against various fungal pathogens, making it an effective tool for disease management in crops. However, like all pesticides, its use should be regulated to prevent resistance development and minimize potential environmental impacts.[4,5,6,7]

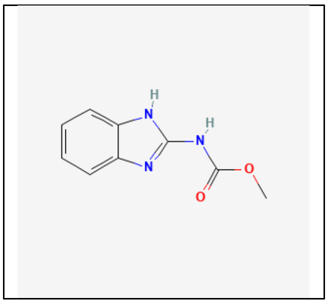

Fig 1: Structure of Carbendazim[4]

Trichoderma harzianum is a naturally occurring fungus that exhibits mycoparasitic behavior, antagonizing plant pathogenic fungi and promoting plant growth through various mechanisms, including competition for nutrients and the secretion of antimicrobial compounds. *Trichoderma harzianum* is a potent biocontrol agent used in agriculture to combat plant diseases. As a beneficial fungus, it establishes a symbiotic relationship with plant roots, promoting growth and increasing nutrient uptake. Its antagonistic properties suppress harmful pathogens, particularly soil-borne fungi, by secreting enzymes that break down their cell walls. This biocontrol mechanism not only protects crops from diseases but also improves overall soil health. Moreover, Trichoderma is environmentally friendly and sustainable, reducing the need for chemical pesticides. Its effectiveness as a biocontrol agent makes it a valuable tool in integrated pest management strategies, ensuring healthier and more resilient crops.[8,9,10,11] Carbendazim is a systemic fungicide that interferes with fungal cell division and is widely used to control a broad spectrum of plant diseases.[12] The combination of biological agents like *Trichoderma* with synthetic fungicides holds the promise of increasing the efficacy of disease management while potentially reducing the dependency on chemical inputs. However, it is essential to investigate the compatibility between *Trichoderma harzianum* and Carbendazim, as interactions between these agents may vary and can impact their overall effectiveness. The present study aims to determine whether the combined application of *Trichoderma* and Carbendazim results in synergistic, antagonistic, or additive effects on fungal growth inhibition and assess the compatibility of *Trichoderma harzianum* with Carbendazim fungicide using the poisoned food technique.

Materials and Methods

- Sample collection

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Test Organism:

Trichoderma harzianum was collected from Microbiology laboratory, Department of Microbiology, Maharani Cluster University, Bengaluru.

Fungicide:

Carbendazim fungicide was obtained from local market, Bengaluru.

- Poisoned Food Technique

The poisoned food technique involves preparing potato dextrose agar (PDA) plates infused with various concentrations of Carbendazim (200 ppm, 400 ppm, 600 ppm, 800 ppm and 1000 ppm). A plug of *Trichoderma* mycelium is placed in the center of each plate, and the plates are incubated under controlled conditions i.e., 27°C for 7 days. The growth inhibition of *Trichoderma* by Carbendazim is observed and recorded.

- Experimental Design

The experiment was set up in a organized design with multiple replicates for each treatment. Observations was recorded at regular intervals over the incubation period.

Results

Table 1: Compatibility of *Trichoderma harzianum* with carbendazim fungicide

Fungicides	Concentration	Mean colony diameter (mm)	Percent of inhibition (%)	Zone of inhibition (mm)
Control	00 ppm	90	0%	0
Carbendazim	200 ppm	0	100%	90
Carbendazim	400 ppm	40	55.5%	50
Carbendazim	600 ppm	o	100%	90
Carbendazim	800 ppm	0	100	90
Carbendazim	1000 ppm	90	0	0

Evaluation of *Trichoderma harzianum* growth in the presence of different concentrations of carbendazim revealed that carbendazim at 1000 ppm was highly compatible with *Trichoderma harzianum* followed by 400 ppm. At all other concentrations viz., 200 ppm, 600 ppm and 800 ppm, *Trichoderma harzianum* was not compatible with carbendazim fungicide

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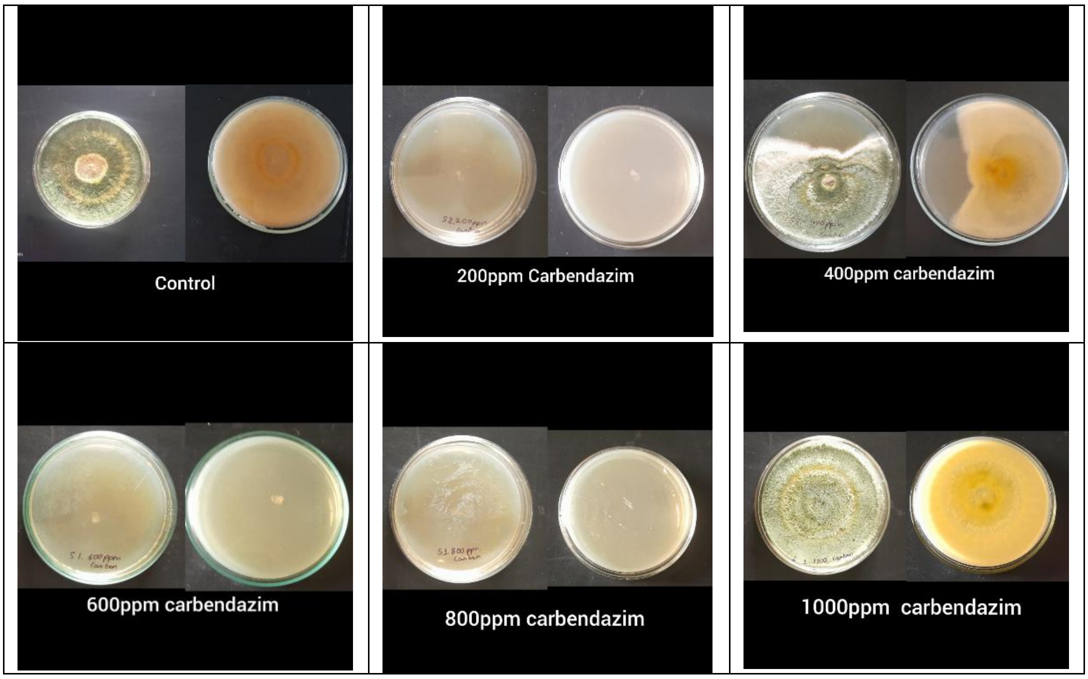

Fig 2: Compatibility of *Trichoderma harzianum* with carbendazim fungicide

Discussion

The study of Bhale, Udhav et al., revealed the compatibility of *Trichoderma spp* with mancozeb and captan fungicide at lower concentrations. At higher concentrations these fungicides inhibited the growth of *Trichoderma spp*.[13] Similarly, in the present study Carbendazim at 1000 ppm was highly compatible followed by 400 ppm. At all other concentrations viz., 200 ppm, 600 ppm and 800 ppm *Trichoderma harzianum* was not compatible with carbendazim fungicide. The study of Amoghavarsha Chittaragi et al., revealed the incompatibility of *Trichoderma asperellum* with captan fungicide.[14] This result is partially in contrast and partially in accordance to our result where carbendazim fungicide favoured the growth of *Trichoderma harzianum* at 1000 ppm and 400 ppm while at all other concentrations it inhibited the growth of *Trichoderma harzianum.* The study of G. Bindu Madhavi et al., revealed the compatibility of Trichoderma viride with pencycuron and propineb fungicide.[15] This result is partially in contrast and partially in accordance to our result where carbendazim fungicide favoured the growth of *Trichoderma harzianum* at 1000 ppm and 400 ppm while at all other concentrations it inhibited the growth of *Trichoderma harzianum*.

The study investigated the compatibility between *Trichoderma harzianum*, a beneficial fungus, and Carbendazim fungicide using the Poisoned Food Technique. The results revealed varying degrees of compatibility between the two agents, indicating the potential impact on their coexistence in agricultural settings. *Trichoderma harzianum* showed remarkable resilience at 1000 ppm concentrations of carbendazim followed by 400 ppm, displaying minimal growth inhibition. However, at all other concentrations, the compatibility diminished, leading to reduced growth *Trichoderma harzianum*. This finding raises concerns about the practicality of combining these agents in certain agricultural practices.

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The research also shed light on the potential long-term consequences of using carbendazim in conjunction with *Trichoderma harzianum*. The presence of the fungicide affected the mycoparasitic activity of *T. harzianum*, which could reduce its efficacy in controlling plant pathogens. This outcome has implications for sustainable agriculture, as it highlights the importance of carefully managing fungicide applications to maintain the biocontrol capabilities of *T. harzianum*. Overall, the study emphasizes the need for cautious and strategic use of carbendazim in agricultural systems where *Trichoderma harzianum* is employed as a biocontrol agent. Understanding the compatibility dynamics between these two agents can help optimize their combined use, ensuring effective pest management while preserving the benefits of the beneficial fungus in sustainable crop production. Further research is necessary to explore alternative approaches that minimize potential conflicts between chemical fungicides and biological control agents, contributing to a more environmentally friendly and efficient agricultural landscape.

Conclusion

The compatibility of *Trichoderma harzianum* with different concentrations of carbendazim fungicide viz., 200 ppm, 400 ppm, 600 ppm, 800 ppm and 1000 ppm was studied using the poisoned food technique. Results revealed that carbendazim at 1000 ppm was highly compatible with *Trichoderma harzianum* followed by 400 ppm. At all other concentrations viz., 200 ppm, 600 ppm and 800 ppm, *Trichoderma harzianum* was not compatible with carbendazim fungicide. Long-term studies on the combined effects of *Trichoderma harzianum* and carbendazim on crop growth and yield would provide a comprehensive understanding of their collective impact on agricultural sustainability.

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