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Research Article

Evaluation of Chemical Management against *Fusarium oxysporum* f. sp. *ciceri* Isolated from Local Fields of Saikheda Region, M.P Using Some Fungicide Formulations

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ABSTRACT

This study aimed to assess the effectiveness of five systemic and six contact fungicides *in vitro* for managing Foc, a significant pathogen causing *Fusarium* wilt in chickpeas (*Cicer arietinum* L.). Using a dual culture technique, the antagonistic capabilities of these fungicides against *Fusarium oxysporum* f. sp. *ciceri* were investigated. Systemic fungicides tested included propiconazole (Tilt), Carbendazim (Bavistin), Kresoxim-methyl+Hexaconazole (Tata ayaan), Hexaconazole (Contaf plus) and Tubeconazole+Sulphur (unspecified), while contact fungicides comprised Zineb (Indofil Z-78), Propineb (Sanipeb), Chlorothalonil (Kavach), Captan (Agrox), Mancozeb (Sparsh) and Copper oxychloride (Bensaan). The inhibition of Foc mycelial growth was evaluated following incubation in a BOD incubator at 25 ± 2°C for 7 days. Results displayed varied efficacy among the tested fungicides, providing insights into their potential for *Fusarium* wilt management in chickpeas. This research contributes to the development of effective strategies for mitigating economic losses associated with *Fusarium* wilt in chickpea cultivation.

Keywords: *Fusarium oxysporum* f. sp. *cicer*; Fungicide; Wilt; Antagonism; *In vitro*

INTRODUCTION

Fusarium wilt, caused by Foc, poses a significant threat to chickpea (*Cicer arietinum* L.) cultivation worldwide, resulting in substantial yield losses and economic repercussions. This soil-borne pathogen infiltrates the plant's vascular system, inducing symptoms such as vascular wilt and stunted growth, ultimately undermining agricultural sustainability and food security in affected regions [1].

Given the challenges associated with developing resistant cultivars and implementing sustainable cultural practices, chemical management remains a pivotal approach for controlling *Fusarium* wilt. However, the emergence of fungicide resistance and environmental concerns necessitate ongoing exploration of novel fungicides and formulations to effectively combat this pathogen. In this regard, *in-vitro* studies serve as indispensable tools for screening and assessing the efficacy of various fungicides against Foc [2].

This study endeavors to evaluate the effectiveness of a diverse array of systemic and contact fungicides in mitigating *Fusarium* wilt caused by Foc in chickpea. Employing a dual culture technique, the antagonistic potential of these fungicides against the pathogen will be rigorously assessed, offering valuable insights into their efficacy and suitability for integration into disease management protocols [3].

A comprehensive understanding of the efficacy of these fungicides is imperative for devising sustainable and integrated management strategies aimed at minimizing yield losses and safeguarding the economic viability of chickpea cultivation. Furthermore, elucidating the performance of these fungicides *in vitro* lays the groundwork for subsequent field evaluations,

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facilitating the development of tailored disease management approaches to effectively combat *Fusarium* wilt .

MATERIALS AND METHODS

Antifungal activity evaluation of fungicides against Foc under *in vitro* conditions

Six contact and five systemic fungicides were assessed *in vitro* against Foc using the poisoned food technique, as described by Nene and Thapliyal. Both the systemic and contact fungicides were tested at a concentration of 1000 ppm. The radial mycelial growth of Foc was observed at 24-hour intervals until untreated control plates were completely covered with mycelial growth. The percentage of mycelial growth inhibition of the pathogen by the test fungicides compared to the untreated control was calculated using the formula provided (Tables 1 and 2) [5].

$$I=(C-T)/C \times 100$$

Where,

I=Percent inhibition

C=Radial growth of test fungus in control plate

T=Radial growth of test fungus in treated plate

Table 1: List of contact fungicide.

Tr no.	Treatment	Trade name
T1	Zineb	Indofil Z-78
T2	Propined 70% WP	Sanipeb
T3	Chlorothalonil 75% WP	Kavach
T4	Captan 50% WP	Agrox
T5	Mancozeb 75% WP	Sparsh
T6	Copper oxychloride 50% WP	Bensaan
T7	Control	-

Table 2: List of systemic fungicide.

Tr no.	Treatment	Trade name
T1	Propiconazole 25% EC	Tilt
T2	Carbendazim 50% WP	Bavistin
T3	Kresoxim-methyl 40% + Hexaconazole 8% WG	Tata ayan
T4	Hexaconazole 5% EC	UPL conquer
T5	Tubeconazole 10% + Sulphur 65% WG	UPL tafuna
T6	Control	-

RESULTS AND DISCUSSION

Evaluation of fungicides against Foc associated with wilt of chickpea contact fungicide

Six contact fungicides Zineb, Propineb, Chlorothalonil, Captan, Mancozeb and copper oxychloride-were evaluated against foc at a concentration of 1000 ppm.

Radial mycelial growth inhibition: The radial mycelial growth of Foc ranged from 19.2 mm to 52.10 mm compared to the control with a radial mycelial growth of 74 mm. Among the evaluated fungicides, Captan exhibited the least radial mycelial growth of 19.2 mm, followed by Mancozeb with 21.64 mm, Propineb with 22.95 mm, Zineb with 24.12 mm, Chlorothalonil with 28.97 mm and Copper oxychloride with 52.10 mm (Table 3 and Figures 1 and 2) [6-8].

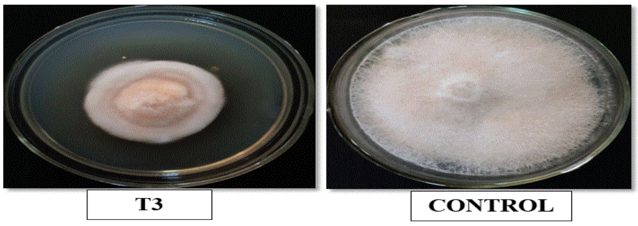

Figure 1: Radial mycelial growth inhibition.

Table 3: *In-vitro* efficacy of contact fungicides against Foc.

Tr no.	Treatment	Colony diameter (mm)	Percentage inhibition (%)
T1	Zineb	24.12	67.4
T2	Propined 70% WP	22.95	68.98
T3	Chlorothalonil 75% WP	28.97	60.85
T4	Captan 50% WP	19.2	74.32
T5	Mancozeb 75% WP		70.75
T6	Copper oxychloride 50% WP	52.1	29.59
T7	Control	74	0

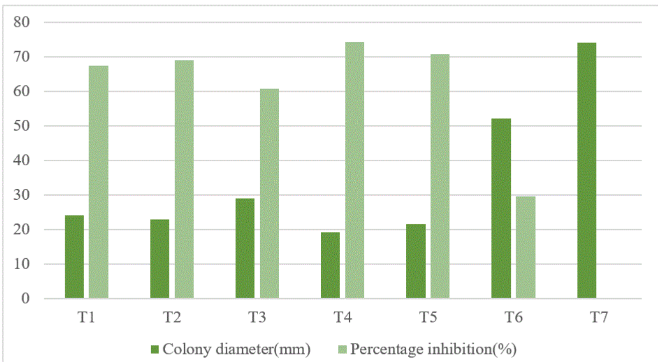

Figure 2: *In-vitro* efficacy of contact fungicide against Foc.

Percentage inhibition of fungal growth: The percentage inhibition of fungal growth varied among the evaluated fungicides. Captan exhibited the highest inhibition percentage at approximately 74.05%, followed by Mancozeb with around 70.70%, Propineb with about 69.00%, Zineb with roughly 67.40%, Chlorothalonil with approximately 60.94% and Copper oxychloride with around 29.73%. These results indicate varying degrees of effectiveness in inhibiting the radial mycelial growth of Foc [9].

Systemic fungicide: Five systemic fungicides-Hexaconazole, Carbendazim, Propiconazole, Tebuconazole and Kresoxim methyl-were evaluated against Foc at a concentration of 1000 ppm [10,11].

Radial mycelial growth inhibition: The radial mycelial growth of Foc was found least in Carbendazim (0 mm) and Tebuconazole (0 mm), followed by Propiconazole (8 mm), Hexaconazole (11 mm) and Kresoxim methyl (23 mm) (Table 4 and Figures 3 and 4) [12-14].

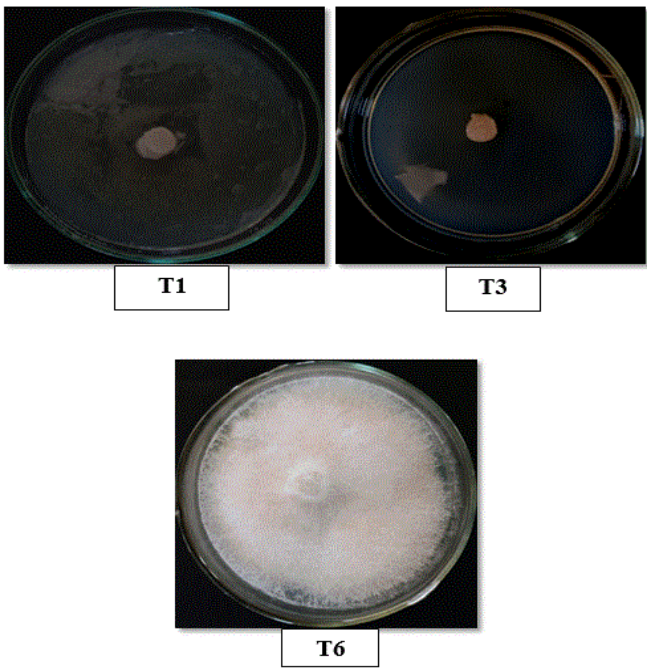

Figure 3: Radial mycelial growth inhibition.

Table 4: *In-vitro* efficacy of systemic fungicides against Foc.

Tr no.	Treatment	Colony diameter(mm)	Percentage inhibition (%)
T1	Hexaconazole	11	85.13
T2	Carbendazim	0	100
T3	Propiconazole	8	89.18
T4	Tebuconazole	0	100
T5	Kresoxim methyl	23	68.91
T6	Control	74	0

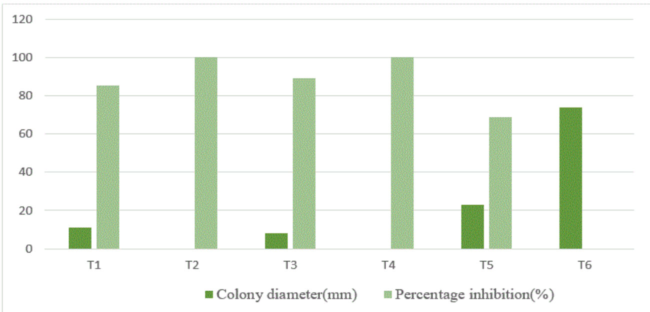

Figure 4: *In-vitro* efficacy of systemic fungicide against Foc.

Inhibition of radial mycelial growth

In assessing the efficacy of systemic fungicides against Foc, the percentage inhibition of fungal growth was determined based on radial mycelial growth measurements. Among the fungicides tested, Hexaconazole exhibited a significant inhibition of fungal growth, with a percentage inhibition of approximately 85.13%. Carbendazim, conversely, demonstrated complete inhibition of fungal growth, achieving a percentage inhibition of 100%. Propiconazole also displayed substantial inhibition, with approximately 89.18% inhibition of fungal growth. Tebuconazole, similar to Carbendazim, exhibited complete inhibition of fungal growth, achieving a percentage inhibition of 100%. Kresoxim methyl, while effective, demonstrated a moderate inhibition of fungal growth, with a percentage inhibition of approximately 68.91%. These findings underscore the varying degrees of effectiveness among the systemic fungicides tested, highlighting Carbendazim and Tebuconazole's complete inhibition and Hexaconazole and Propiconazole's substantial inhibitory activity against Foc [15-20].

CONCLUSION

The assessment of contact and systemic fungicides against Foc revealed distinct patterns of inhibition in radial mycelial growth, offering valuable insights into their efficacy in combating this pathogen. Among the contact fungicides, Captan emerged as the most effective in inhibiting fungal growth, followed by Mancozeb, Propineb, Zineb, Chlorothalonil and Copper oxychloride, each exhibiting varying degrees of effectiveness. Notably, Captan demonstrated the highest inhibition percentage, indicating its potent antifungal activity against Foc.

In contrast, systemic fungicides displayed diverse efficacy profiles, with Carbendazim and Tebuconazole showcasing complete inhibition of fungal growth, followed by Propiconazole, Hexaconazole and Kresoxim methyl. Carbendazim particularly stood out for its comprehensive inhibition, while Hexaconazole and Propiconazole also demonstrated significant inhibitory activity. These results underscore the importance of selecting suitable fungicides tailored to the specific pathogen and understanding their mode of action for effective disease management strategies.

In conclusion, our *in vitro* study highlights carbendazim as the most effective fungicide against Foc among the tested options. This research provides valuable guidance for selecting and utilizing fungicides to combat Fusarium wilt caused by Foc, contributing to the development of sustainable and effective disease control strategies in chickpea cultivation. Further research is needed to confirm these findings in field conditions and to explore integrated disease management approaches aimed at reducing crop losses and ensuring food security.

CONFLICT OF INTEREST

The authors of present work puts no conflict of interest as the research work is performed in the centralized level in the university itself without any interference of second party/ institute.

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