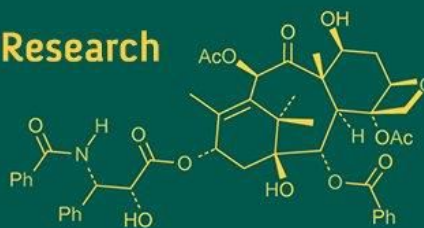


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In-vitro efficacy of systemic, non-systemic and combi-fungicides against *Alternaria porri* causing purple blotch of onion

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Abstract

Purple blotch of onion, incited by *Alternaria porri*, poses a serious threat to onion cultivation, significantly impacting both yield and bulb quality. The present study was conducted to evaluate the *in vitro* efficacy of different categories of fungicides systemic, non-systemic, and combi-fungicides against the most virulent isolate (ChAp1) of *A. porri*, using the poisoned food technique on PDA medium. Systemic fungicides (seven in total) were tested at 500 and 1000 ppm. Four fungicides—Propiconazole, Hexaconazole, Difenconazole, and Tebuconazole—completely inhibited fungal mycelial growth (0.00 mm) and achieved 100% inhibition at both concentrations. These treatments were statistically at par and significantly superior over others. Pyraclostrobin exhibited 90.03% and 90.92% inhibition at 500 and 1000 ppm, respectively, while Thiophanate methyl recorded 72.40% and 83.51% inhibition. Azoxystrobin was the least effective among systemic fungicides, showing 62.40% inhibition at 500 ppm and 70.18% at 1000 ppm.

Non-systemic fungicides (seven in total) were evaluated at 2000 and 2500 ppm concentrations. The most effective were Copper hydroxide (93.14% and 94.06%), Mancozeb (90.92% and 93.14%), and Dinocap (89.07% and 90.23%). Other effective treatments included Propineb (85.55% and 87.03%) and Copper oxychloride (83.51% and 88.14%). Thiram was the least effective, showing 69.81% inhibition at 2000 ppm and 77.59% at 2500 ppm. Combi-fungicides (seven combinations) were also tested at 2000 and 2500 ppm. Captan 70% + Hexaconazole 5% showed 100% inhibition at both concentrations, outperforming all other treatments. This was followed by Trifloxystrobin 25% + Tebuconazole 50% (92.58% and 93.14%), Hexaconazole 4% + Zineb 68% (91.12% and 91.14%), and Thiophanate methyl 45% + Pyraclostrobin 5% (89.81% and 91.12%). The least effective among the combinations was Metiram 50% + Pyraclostrobin 5%, with inhibition rates of 86.48% and 88.51%, respectively.

The study conclusively demonstrated that among all fungicides tested, Captan + Hexaconazole, Propiconazole, Copper hydroxide, and Mancozeb are the most effective in suppressing *A. porri* under *in vitro* conditions. These results are in agreement with previous studies and offer a valuable reference for integrated disease management of purple blotch in onion crops.

Keywords: *Alternaria porri*, inhibition, systemic, non-systemic combi-fungicides, purple blotch

Introduction

Onion (*Allium cepa* L.) is one of the most widely cultivated and consumed vegetable crops globally, occupying an important position in Indian agriculture for its culinary, nutritional, and economic value. India is the second-largest onion producer in the world, with an annual output of approximately 26.74 million metric tonnes from 1.42 million hectares during 2022-23 (NHB, 2023) [12]. Maharashtra is the leading producer, contributing about 33-35% of the national yield, with major cultivation in Nashik, Pune, Ahmednagar, and Jalgaon districts. Despite its significance, onion production is seriously hampered by fungal diseases, among which purple blotch, caused by *Alternaria porri* (Ellis) Cif., is one of the most destructive foliar pathogens. Depending on environmental conditions, cultivar susceptibility, and crop stage, yield losses may range from 20% to 70% (Mishra *et al.*, 2014; Pandey *et al.*, 2019) [8, 13]. In Maharashtra, outbreaks have become more frequent during the post-monsoon and Rabi seasons, when high humidity and moderate temperatures (25-30 °C) favour disease development.

The disease manifests initially as small, water-soaked, whitish sunken lesions on older leaves, which enlarge into purplish-brown concentric rings with yellow halos. These lesions lead to early leaf senescence, reduced bulb size, and lower marketable yield. Windborne spores contribute to rapid secondary spread, especially in dense canopies and under poor crop rotation practices.

Fungicide application remains the primary control strategy, but indiscriminate use has resulted in resistance development, phytotoxicity, and environmental concerns (Prajapati *et al.*, 2021) ^[14]. To mitigate these issues, recent research has focused on the rational use of systemic and protective fungicides, along with combi-formulations that can minimise resistance risks and expand control spectra. Triazole-based fungicides such as tebuconazole, hexaconazole, and propiconazole have been shown to effectively suppress *A. porri* growth under both *in vitro* and field conditions (Mohan *et al.*, 2004; Yadav *et al.*, 2017) ^[9, 18]. Protective fungicides like mancozeb and copper hydroxide remain integral in integrated disease management programmes, while combi-fungicides are increasingly valued for their dual mode of action and high performance under severe disease pressure (Ravichandran, 2012) ^[16].

Considering this background, the present study was undertaken to assess the *in vitro* efficacy of selected systemic, non-systemic, and combi-fungicides against the most virulent isolate of *A. porri* (ChAp1) collected from infected onion fields in Maharashtra, with the aim of identifying fungicides that can be integrated into sustainable disease management programmes.

Materials and Methods

The present study on purple blotch of onion, caused by *Alternaria porri* (Ellis) Cif., was conducted *in vitro* at the Department of Plant Pathology, VNMKV, Parbhani, Maharashtra.

Isolation and Identification of the Pathogen

The most virulent isolate of *A. porri* (designated ChAp1) was obtained from naturally infected onion leaves showing typical purple blotch symptoms. Infected leaf tissues were surface sterilised with 0.1% sodium hypochlorite for 30 seconds, rinsed thoroughly in sterile distilled water, and placed on potato dextrose agar (PDA) medium. Plates were incubated at 25±2 °C for seven days. Fungal colonies were sub-cultured to obtain pure cultures. Identification was confirmed based on morphological characteristics such as conidial shape, beak length, and septation, following the descriptions of Ellis (1971) ^[3].

Preparation of Culture Medium

PDA was prepared by boiling 200 g of peeled potatoes in 1 L of water for 30 minutes, filtering the extract, and adding 20 g dextrose and 15 g agar. The medium was autoclaved at 121 °C for 20 minutes and poured into sterile Petri plates under laminar airflow.

In Vitro Evaluation using the Poisoned Food Technique

The poisoned food technique described by Nene and Thapliyal (1993) ^[11] was used to evaluate fungicide efficacy. The required quantity of each fungicide was incorporated into molten PDA (cooled to approximately 45 °C) to achieve the desired concentration before pouring into sterile Petri plates. Once solidified, a 5 mm diameter mycelial disc

from the actively growing margin of a seven-day-old *A. porri* culture was placed in the centre of each plate. Each treatment was replicated three times, and an untreated control was maintained for comparison. Plates were incubated at 25±2 °C for seven days, after which radial mycelial growth was recorded in millimetres.

The percentage inhibition of mycelial growth was calculated using the formula given by Vincent (1927) ^[21]:

$$\text{Percent Inhibition} = C - T / C \times 100$$

Where C is the mycelial growth in the control (mm) and T is the mycelial growth in the treatment (mm).

Evaluation of Systemic Fungicides

The efficacy of systemic fungicides against *A. porri* (ChAp1) was assessed at concentrations of 500 and 1000 ppm using PDA as the basal medium. The experiment was laid out in a Completely Randomised Design (CRD) with three replications and eight treatments:

Tr. No.	Treatment
T ₁	Propiconazole 25% EC
T ₂	Hexaconazole 5% EC
T ₃	Difenoconazole 25% EC
T ₄	Tebuconazole 25.9% EC
T ₅	Pyraclostrobin 20% WG
T ₆	Thiophanate methyl 70% WP
T ₇	Azoxystrobin 25% EC
T ₈	Control (untreated)

Evaluation of Non-Systemic Fungicides

Non-systemic/contact fungicides were evaluated at 2000 and 2500 ppm *in vitro* using the same poisoned food technique and PDA medium. The experiment followed a CRD with three replications and eight treatments:

Tr. No.	Treatment
T ₁	Dinocap 48% EC
T ₂	Copper oxychloride 50% WP
T ₃	Mancozeb 75% WP
T ₄	Copper hydroxide 77% WP
T ₅	Chlorothalonil 75% WP
T ₆	Propineb 70% WP
T ₇	Thiram 75% WP
T ₈	Control (untreated)

Evaluation of Combi-Fungicides

The efficacy of combi-fungicides was tested at 2000 and 2500 ppm *in vitro* using PDA as the basal medium and the poisoned food technique. The experiment was conducted in CRD with three replications and eight treatments:

Tr. No.	Treatment
T ₁	Thiophanate methyl 45% + Pyraclostrobin 5% (50% WP)
T ₂	Hexaconazole 4% + Zineb 68% (72% WP)
T ₃	Trifloxystrobin 25% + Tebuconazole 50% (75% WG)
T ₄	Captan 70% + Hexaconazole 5% (75% WP)
T ₅	Azoxystrobin 20% + Difenoconazole 12.5% (32% EC)
T ₆	Metalaxyl 8% + Mancozeb 64% (72% WP)
T ₇	Metiram 50% + Pyraclostrobin 5% (60% WG)
T ₈	Control (untreated)

Observations on radial mycelial growth and sporulation were recorded at 24-hour intervals until the growth in the control plates completely covered the surface.

Results and Discussion

(Table 1) revealed that among the systemic fungicides tested (each @ 500, 1000 ppm) were found effective against the *A. porri* pathogen. The mycelial growth recorded with the systemic fungicides ranged from 00.00 mm to 33.83 mm @ 500 ppm and from 00.00 mm to 26.83 mm @ 1000 ppm. Whereas, mycelial growth inhibition with the systemic fungicides ranged from 62.40 to 100 percent and 70.18 to 100 percent, respectively @ 500 and 1000 ppm.

Table 1: *in vitro* evaluation of systemic fungicides against *Alternaria porri*

Tr. No	Treatment details	Radial mycelia growth (mm)*		Percent inhibition*	
		500	1000	500	1000
T ₁	Propiconazole 25% EC	0.00	0.00	100 (90.00)	100 (90.00)
T ₂	Hexaconazole 25% EC	0.00	0.00	100 (90.00)	100 (90.00)
T ₃	Difeneconazole 25% EC	0.00	0.00	100 (90.00)	100 (90.00)
T ₄	Tebuconazole 25.9% EC	0.00	0.00	100 (90.00)	100 (90.00)
T ₅	Pyraclostrobin 20% WG	8.96	8.16	90.03 (71.59)	90.92 (72.44)
T ₆	Thiophanat methyl 70% WP	24.83	14.83	72.40 (58.29)	83.51 (66.05)
T ₇	Azoxystrobin 25% EC	33.83	26.83	62.40 (52.16)	70.18 (56.88)
T ₈	Control (untreated)	90.00	90.00	0.00 (0.00)	00 (0.00)
	S.E. (m)±	0.50	0.45	0.55	0.50
	C.D.at 1%	1.52	1.38	1.69	1.53

At 500 ppm concentration of systemic fungicides, there was no growth of *Alternaria porri* was observed in the treatments of propiconazole, Hexaconazole, Difeneconazole and Tebuconazole (00.00 mm). The next best treatments followed by these were pyraclostrobin (8.96 mm), Thiophanate methyl (24.83 mm). Amongst all fungicides tested, Azoxystrobin was found comparatively less effective with having maximum growth of *A. porri* i.e. (33.83 mm).

Among the fungicides tested at 500 ppm, cent percent inhibition of the test pathogen was observed in the treatment of propiconazole, Hexaconazole, Difeneconazole and Tebuconazole, are significantly superior over other treatments including control and these are statistically at par with each other, which was followed by Pyraclostrobin (90.03%) and Thiophanate methyl (72.40%). Among the, Azoxystrobin was found comparatively less effective with minimum mycelial inhibition of pathogen i.e. 62.40 percent. At 1000 ppm concentration of systemic fungicides, there was total inhibition of *Alternaria porri* was observed in the treatments of propiconazole, Hexaconazole, Difeneconazole and Tebuconazole (00.00 mm) followed by this were pyraclostrobin (8.16 mm), Thiophanate methyl (14.83 mm). Among the all fungicides tested, Azoxystrobin was found comparatively less effective with having maximum growth of *A. porri* i.e. (26.83 mm.) Among the fungicides tested at 1000 ppm, cent percent inhibition of the test pathogen was observed in the treatment of propiconazole, Hexaconazole, Difeneconazole and Tebuconazole, are significantly superior over other treatments including control and these are statistically at par with each other, which were followed by Pyraclostrobin (90.92%) and Thiophanate methyl (83.51%). Among all systemic fungicides, Azoxystrobin was found comparatively less effective with minimum mycelial inhibition of pathogen i.e. 70.18 percent.

The observations of the present studies are found similar with the reports of earlier researchers where Mohan *et al.*, (2004) ^[9] studied the efficacy *in-vitro* of nine fungicides against *stemphylium blight* (*S.botryosum*) of onion. The fungicides Tebuconazole (Folicur 250 EW) @ 0.05%, Difeneconazole (Score 25 EC) @ 0.05%, Hexaconazole (Contaf 5 EC) @ 0.05%, Propineb (Anthracol 70 WP) @ 0.25%, Iprobenphos (Kitazin 48EC) @ 0.10%, Chlorothalonil (Kavach 75WP) @ 0.30%, Tricyclazole (Sivic 75WP) @ 0.10%, Carbendazim (Bavistin 50 WP) @ 0.10% and Mancozeb (Indofil M-45 WP) @ 0.30%. were evaluated highest growth inhibition of the test fungus was caused with the fungicides, Tebuconazole followed by Difeneconazole, Hexaconazole, Carbendazim, Iprobenphos.

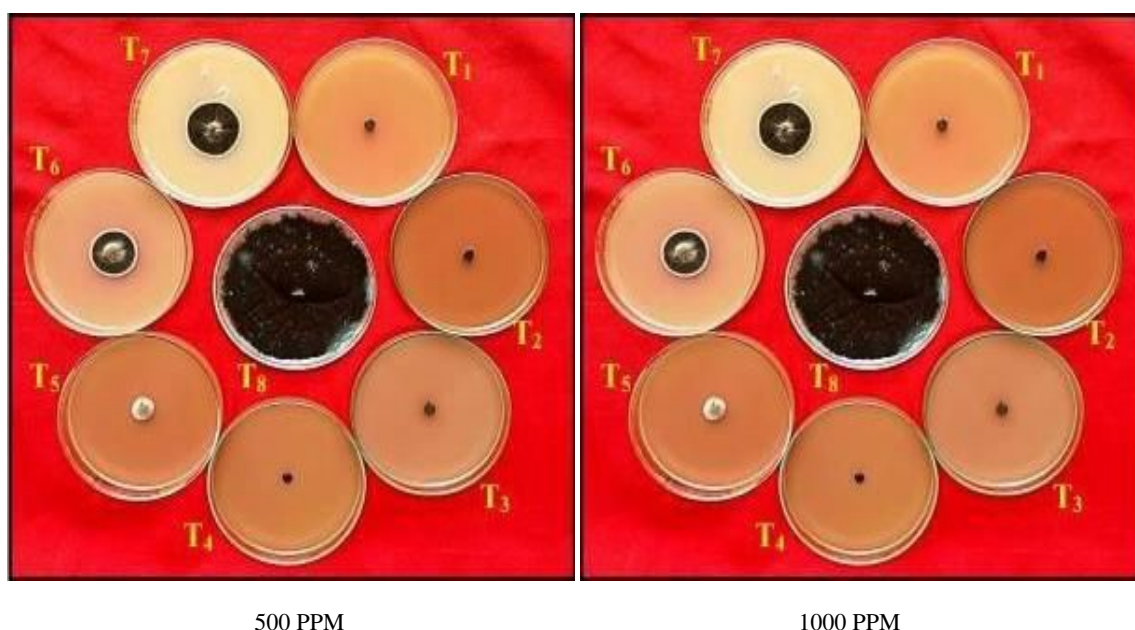


Plate 1: *In-vitro* efficacy of systemic fungicides against *Alternaria porri* (ChAp1)

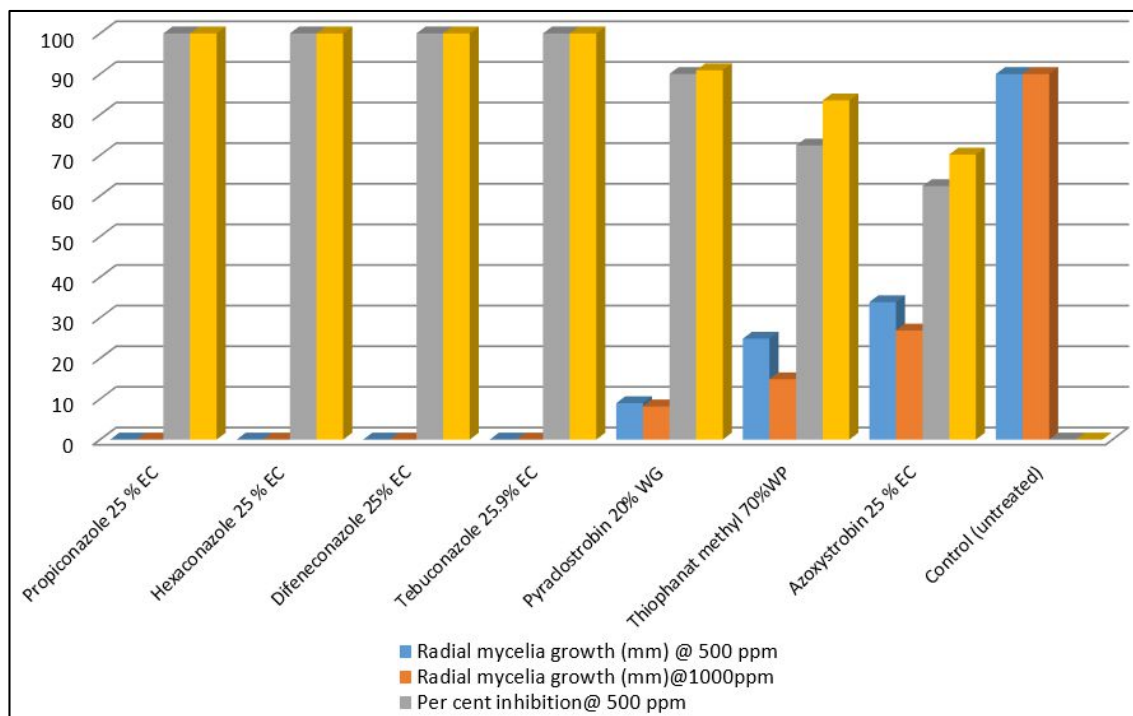


Fig 1: *In vitro* evaluation of systemic fungicides against *Alternaria porri* ChAp1

***In vitro* evaluation of Non-systemic fungicides against *Alternaria porri*:**

Results (Table 2 Plate 2 and Fig 2) revealed that among the seven nonsystemic fungicides tested (each @ 2000 and 2500 ppm) were found effective against the *A. porri* pathogen. The mycelial growth with the non-syestemic fungicides ranged from 6.16 mm to 27.16 mm @ 2000 ppm and 5.33 mm to 20.16 mm @ 2500 ppm. Whereas, mycelial growth inhibition with the non-syestemic fungicides ranged from 69.81 to 100 percent and 77.59 to 100 percent @ 2000 and 2500 ppm respectively.

At 2000 ppm concentration of non-systemic fungicides, the least growth of *Alternaria porri* was observed in the treatment of Copper hydroxide (6.16 mm). The next best treatment followed by this was Mancozeb (8.16 mm) which was followed by Dinocap (9.83 mm), Propineb (13.00 mm), Copper oxychloride (14.83 mm), Chlorothalonil (22.16 mm). Amongst all the treatments Thiram was found comparatively less effective with maximum mycelial growth of *Alternaria porri* (i.e. 27.16 mm). Among all the fungicides tested at 2000 ppm concentration Copper hydroxide, Mancozeb and Dinocap were significantly superior over rest of treatments including control with highest mycelial growth inhibition of 93.14%, 90.92% and 89.07% respectively. These were followed by Propineb (85.55%), Copper oxychloride (83.51%), Chlorothalonil (75.37%). Among these Thiram was found less effective with 69.81 percent inhibition of *A. porri* pathogen.

At 2500 ppm concentration of non-systemic fungicides, the least growth of *Alternaria porri* was observed in the treatment of Copper hydroxide (5.33 mm) and Mancozeb (6.16mm) which were found significantly superior over all the treatments followed by Dinocap (8.33 mm), Propineb (10.66 mm), Copper oxychloride (11.66 mm), Chlorothalonil (18.16 mm). Among the treatments Thiram was found comparatively less effective with maximum mycelial growth of *Alternaria porri* (i.e. 20.16 mm). Among all non-sytemic fungicides tested at 2500 ppm concentration Copper hydroxide, Mancozeb and Dinocap

were significantly superior over rest of treatments including control with highest mycelial growth inhibition of 94.06%, 93.14% and 90.23% respectively. These were followed by Propineb (87.03%), Copper oxychloride (88.14%), Chlorothalonil (79.81%). Among these Thiram was found less effective with 77.59 percent inhibition of *A. porri* pathogen.

The observations of the present studies are found similar with the reports of earlier researchers where Kumari *et al.*, (2006) evaluated the efficacy of six fungicides (*in vitro* and *in vivo*) against *Alternaria blight* (*Alternaria alternata*) of periwinkle. Mancozeb 75 WP followed by Captafol 50 WP and Copper oxy-chloride 50 WP (@ 0.15, 0.20, 0.25% each) were most effective in inhibiting mycelial growth and conidial germination, which recorded mean mycelial inhibition of 70.33, 69.61 and 51.67 percent respectively.

Table 2: *in vitro* evaluation of Non-systemic fungicides against *Alternaria porri*

Tr. No	Treatment details	Radial mycelia growth (mm)*		Percent inhibition*	
		2000	2500	2000	2500
T ₁	Dinocap 48% E	9.83	8.33	89.07 (70.67)	90.23 (72.25)
T ₂	Copper-oxychloride 50% WP	14.83	11.66	83.51 (66.02)	88.14 (69.84)
T ₃	Mancozeb 75% WP	8.16	6.16	90.92 (72.44)	93.14 (74.79)
T ₄	Copper hydroxide 77% WP	6.16	5.33	93.14 (74.79)	94.06 (75.87)
T ₅	Chlorothalonil 75% WP	22.16	18.16	75.37 (60.22)	79.81 (63.27)
T ₆	Propineb 70% WP	13.00	10.66	85.55 (67.64)	87.03 (67.87)
T ₇	Thiram 75% WP	27.16	20.16	69.81 (56.65)	77.59 (61.72)
T ₈	Control (untreated)	90.00	90.00	0.00 (0.00)	00 (0.00)
	S.E. (m)±	0.48	0.35	0.54	0.39
	C.D.at 1%	1.48	1.08	1.64	1.20



Plate 2: *In vitro* efficacy of non-systemic fungicides against *Alternaria porri* ChAp1

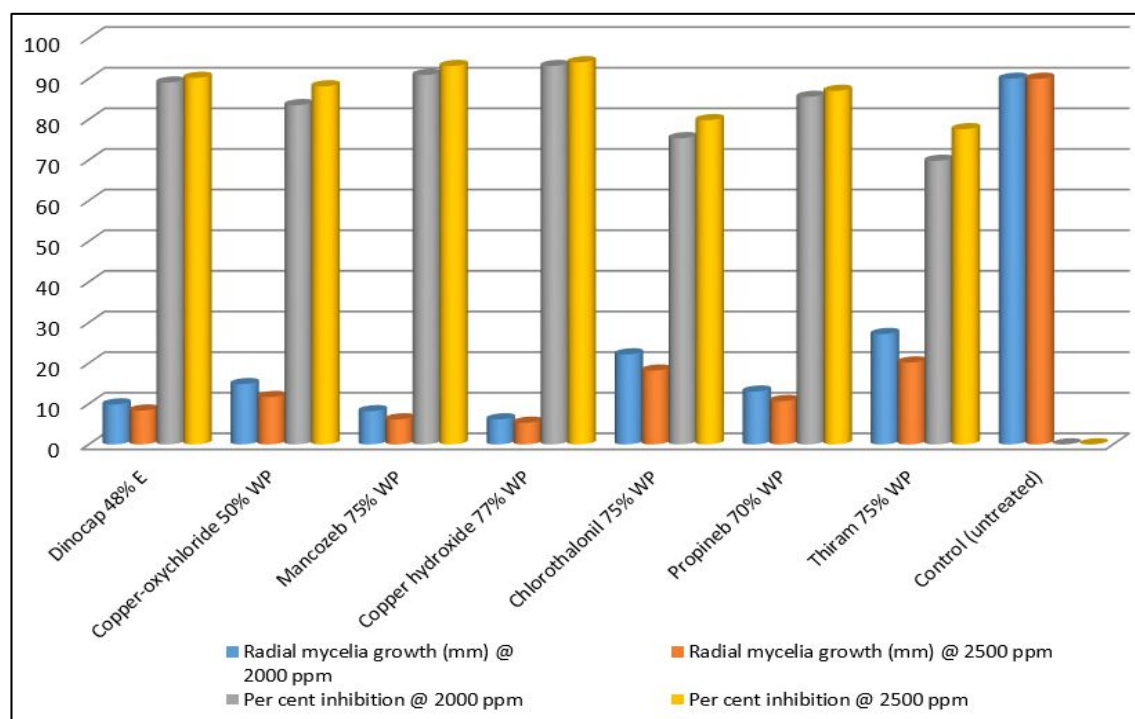


Fig 2: *In vitro* evaluation of Non-systemic fungicides against *Alternaria porri* ChAp1

***In vitro* evaluation of combi-fungicides against *Alternaria porri*:**

Results (Table 3 Plate 3 and Fig 3) revealed that among the combifungicides tested (each @ 2000 and 2500 ppm), were found effective against the test pathogen. The mycelial growth with the combi-fungicides ranged from 0.00 mm to 12.16 mm @ 2000 ppm and from 0.00 mm to 10.33 mm @ 2500 ppm. Whereas, mycelial growth inhibition with the combi-fungicides ranged from 86.48 to 100 percent and 88.51 to 100 percent @ 2000 and 2500 ppm respectively.

At 2000 ppm concentration combi-fungicides, the least growth of *Alternaria porri* was observed in the treatment of Captan 70% + Hexaconazole 5% (0.00 mm) is significantly superior over rest of the treatments including control. The next best treatment followed by this was Trifloxystrobin 25% + Tebuconazole 50% (6.66 mm) which was followed by Hexaconazole 4% + Zineb 68% (7.83 mm), Thiophanatemethyl 45% + Pyraclostrobin 5% (9.16 mm),

Azoxystrobin 20% + Difenoconazole 12.5% (9.33 mm), Metalaxyl 8% + Mancozeb 64% (10.00 mm). Among the treatments Metiram 50% + Pyraclostrobin 5% was found comparatively less effective with maximum mycelial growth of *Alternaria porri* i.e. 12.16 mm. Among all the fungicides tested at 2000 ppm concentration Captan 70% + Hexaconazole 5% was significantly superior over rest of treatments including control with highest mycelial growth inhibition of 100%. This was followed by Trifloxystrobin 25% + Tebuconazole 50% (92.58%), Hexaconazole 4% + Zineb 68% (91.12%), Thiophanatemethyl 45% + Pyraclostrobin 5% (89.81%), Azoxystrobin 20% + Difenoconazole 12.5% (89.62%), Metalaxyl 8% + Mancozeb 64% (88.88%). Amongst these Metiram 50% + Pyraclostrobin 5% was found less effective with 86.48 percent inhibition of test pathogen as compared to other treatments.

At 2500 ppm concentration of combi-fungicides, the least growth of *Alternaria porri* was observed in the treatment of Captan 70% + Hexaconazole 5% (0.00 mm) is significantly superior over rest of the treatments including control. The next best treatment followed by this was Trifloxystrobin 25% + Tebuconazole 50% (6.16 mm) which was followed by Hexaconazole 4% + Zineb 68% (7.66 mm), Thiophanatemethyl 45% + Pyraclostrobin 5% (7.83 mm), Azoxystrobin 20% + Difenconazole 12.5% (8.33 mm), Metalaxyl 8% + Mancozeb 64% (9.33 mm). Amongst all the treatments Metiram 50% + Pyraclostrobin 5% was found comparatively less effective with maximum mycelial growth of *Alternaria porri* i.e. 10.33 mm. Among all the fungicides tested at 2500 ppm concentration Captan 70% + Hexaconazole 5% was significantly superior over rest of treatments including control with highest mycelial growth inhibition of 100%. This was followed by Trifloxystrobin 25% + Tebuconazole 50% (93.14%), treatments Hexaconazole 4% + Zineb 68% (91.14%) and Thiophanatemethyl 45% + Pyraclostrobin 5% (91.12%) are statistically at par with each other which was followed by Azoxystrobin 20% + Difenconazole 12.5% (90.73%),

Metalaxyl 8% + Mancozeb 64% (89.62%) . Among these Metiram 50% + Pyraclostrobin 5% was found less effective with 88.51 percent inhibition of test pathogen as compared to other treatments.

The observations of the present studies are found similar with the reports of earlier researchers where Ravichandran (2012) [16] studied the *invitro* efficacy of twelve fungicides against *A. porri* Among the tested fungicides, Mancozeb, (Mancozeb 12% + Marbendazim 63% WP) and (Zineb 68% + Hexaconazole 4% WP) at 0.1, 0.15 and 0.20 percent recorded 100 percent mycelial inhibition. While, Hexaconazole at 0.05 and 0.10 percent and Propiconazole, Tebuconazole at 0.10 percent recorded 100 percent inhibition in the mycelial growth.

Yadav *et al.*, (2017) [18] studied efficacy of six systemic fungicides and two non-systemic fungicides against purple blotch of onion. The study revealed that, Tebuconazole at 0.025, 0.50, 0.10 and 0.20 percent followed by Difenconazole and (Tebuconazole 50% + Trifloxystrobin 25% WP) at (0.10 and 0.20%) and Propiconazole at (0.20%) recorded 100 percent inhibition in the mycelial growth of the test pathogen.

Table 3: *in vitro* evaluation of combi fungicides against *Alternaria porri*

Tr. No	Treatment details	Radial mycelia growth (mm)*		Percent inhibition*	
		2000	2500	2000	2500
T ₁	Thiophanate-methyl 45% + Pyraclostrobin 5% (50% WP)	9.16	7.83	89.81 (71.36)	91.12 (72.64)
T ₂	Hexaconazole 4% + Zineb 68% (72%WP)	7.83	7.66	91.12 (72.64)	91.14 (72.65)
T ₃	Trifloxystrobin 25% + Tebuconazole 50% (75%WG)	6.66	6.16	92.58 (74.17)	93.14 (74.79)
T ₄	Captan 70% + Hexaconazole 5% (75%WP)	0.00	0.00	100 (90.00)	100 (90.00)
T ₅	Azoxystrobin 20% + Difenconazole 12.5% (32% EC)	9.33	8.33	89.62 (71.18)	90.73 (72.25)
T ₆	Metalaxyl 8% + Mancozeb 64% (72% WP)	10.00	9.33	88.88 (70.51)	89.62 (71.18)
T ₇	Metiram 50% + Pyraclostrobin 5% (60% WG)	12.16	10.33	86.48 (68.40)	88.51 (70.16)
T ₈	Control (untreated)	90.00	90.00	0.00 (0.00)	00 (0.00)
	S.E. (m)±	0.26	0.14	0.28	0.13
	C.D.at 1%	0.79	0.43	0.86	0.39



Plate 3: *In vitro* evaluation of combi-fungicides against *Alternaria porri* ChAp1

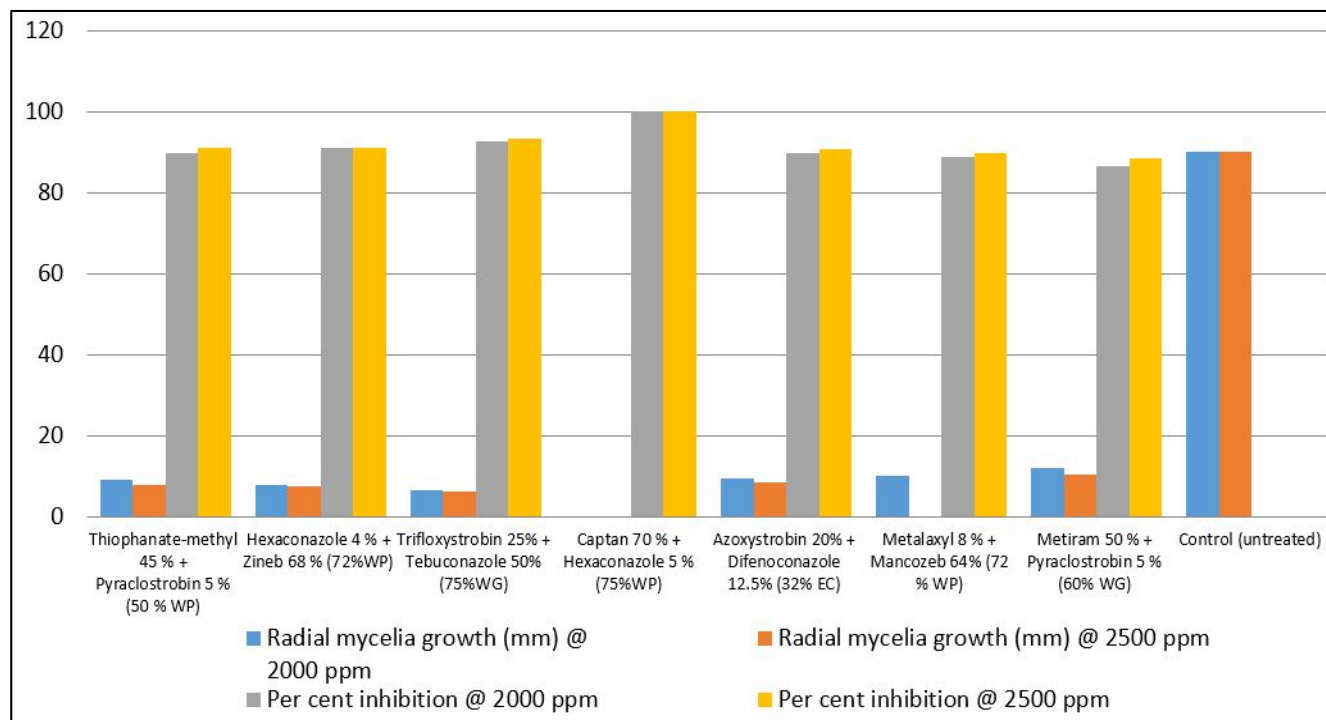


Fig 3: *In vitro* evaluation of combi-fungicides against *Alternaria porri* ChAp1

Conclusion

The present study clearly demonstrates the effectiveness of various systemic, non-systemic, and combi-fungicides against the most virulent isolate of *Alternaria porri* (ChAp1), the causal organism of purple blotch in onion. Among the systemic fungicides, Propiconazole, Hexaconazole, Difenoconazole, and Tebuconazole provided complete inhibition of fungal growth at both 500 and 1000 ppm concentrations, indicating their high efficacy. In the category of non-systemic fungicides, Copper hydroxide and Mancozeb were found significantly effective, achieving over 93% inhibition at 2500 ppm. Among the combi-formulations, Captan + Hexaconazole achieved 100% inhibition at both concentrations and was found superior over other treatments.

These findings suggest that certain triazole-based systemic fungicides and copper-based non-systemic and combi-fungicides are highly effective in suppressing *A. porri* under *in vitro* conditions. The use of these fungicides, either alone or in rotation, may serve as a key component of integrated disease management (IDM) strategies for controlling purple blotch in onions. However, further *in vivo* validation under field conditions is recommended to confirm their efficacy and economic feasibility before recommending them for large-scale use.

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