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In vitro evaluation of new molecules of fungicides against *Colletotrichum capsici* (Syd.) Butler and Bisby causing anthracnose of chilli

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ABSTRACT

Chilli (*Capsicum annuum* L.) is the fourth major vegetable cultivated globally. The major fungal foliar pathogen causing havoc in production, export and marketing is fruit rot or anthracnose of chilli caused by *Colletotrichum capsici* (Syd.) Butler and Bisby which has emerged in impairing production in both tropical and subtropical regions. In the present study, new molecules of contact, systemic and combi product fungicides were tested against *Colletotrichum capsici* by poison food technique at different concentrations. The contact fungicides were tested at three concentrations (0.1, 0.2 and 0.3%) where, mancozeb 75% WP recorded 100 percent mycelial inhibition at all three concentrations. Among the systemic fungicides, propiconazole 25% EC and difenoconazole 25% EC showed 100 per cent mycelial inhibition at 0.025, 0.05 and 0.10 per cent. Among the combi product fungicides evaluated, metalaxyl 8% + mancozeb 64% WP showed 100 per cent inhibition which was on par with tricyclazole 18% + mancozeb 62% (99.54 %). Whereas, lowest mycelial inhibition was in zineb 75% WP (30.14 %), hexaconazole 5% EC (66.11 %) and tebuconazole 50% + trifloxystrobin 25% (72.36 %) in contact, systemic and combi fungicides respectively. The overall results suggest that the systemic fungicides of triazole group are highly effective in inhibiting mycelial growth.

Key words : *Chilli, Anthracnose, Poison food technique, Fungicides*

Introduction

Capsicum genus consists of approximately twenty-two wild species and five domesticated species *viz.*, *C. annuum, C. frutescens, C. baccatum, C. pubescens* and *C. chinense*. Having chromosome number 2*n* = 24, *Capsicum* species may be herb or sub-shrub of height up to 2.5 m with extensively branched hairy growth stem with purplish spots near the nodes.

Fresh green chilli fruits are rich in vitamin C, while red chilli fruits have more vitamin A content. The active component of chilli is capsaicin which possesses the antioxidant, anti-carcinogenic, anti-mutagenic and immuno suppressive activities having ability to inhibit platelet aggregation and bacterial growth.It is also a rich source of red pigments *viz.*, capsanthin, capsorubin, cryptoxanthin and related carotenoids which are esters of capsanthin. Apart from this, oleoresin extracted from chillies is extensively used in western countries in food prepa-

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rations, beverage industries, medicine and cosmetics (Saxena *et al.*, 2016).

India's area, production and productivity of dry chillies are 702 thousand hectares, 2094 thousand metric tonnes (MT) and 2.9 MT/ ha respectively. Among the states, Andhra Pradesh occupies the first position with an area of 177.46 thousand ha, production of 796.65 thousand MT and productivity of 4.49 MT/ ha whereas, Karnataka occupies fourth position with an area of 85.60 thousand ha, production of 147.05 thousand MT and productivity of 1.72 MT/ ha. In green chillies India covers an area of 411 thousand ha, 4363 thousand MT and productivity of 10.6 MT/ ha, among the states Karnataka occupies prime position with production of 959.01 thousand MT and area of 60.63 thousand ha followed by Andhra Pradesh (506.87 thousand MT) (Anon., 2020).

The sustainability of chilli is affected by various biotic and abiotic stresses, currently biotic factors such as fungi, virus, bacteria and nematodes are posing a major threat. Among all these, major fungal foliar pathogen causing havoc in production, export and marketing is anthracnose of chilli, which has emerged in impairing production in both tropical and subtropical regions (Rahman *et al.,* 2011).

Fruit rot causes extensive pre and post-harvest damage to chilli fruits causing anthracnose lesions. Appearance of even small lesions on chilli fruits reduce their marketable value.Four major *Colletotrichum* species including *C. acutatum* (Simmonds), *C. capsici* (Syd.) Butler and Bisby, *C. gloeosporioide*s (Penz.) Penz. and Sacc. and *C. coccodes* (Wallr.) S. Hughes are known to reduce marketable yield from 10 to 80 per cent (Manandhar *et al.*, 1995).

Materials and Methods

The present investigation was carried out during 2021 at the Department of Plant Pathology, College of Agriculture, Dharwad, Karnataka. Different contact, systemic and combi product fungicides were tested against *C. capsici* using poisoned food technique (Nene and Thapliyal, 1993) under *in vitro* conditions. The contact fungicides were evaluated at 0.1, 0.2 and 0.3 per cent concentrations whereas, the systemic fungicides were evaluated at 0.025, 0.05 and 0.10 per cent and combi product fungicides were evaluated at 0.1, 0.2 and 0.3 per cent concentrations.

Data analysed with ANOVA in factorial completely randomized design using SPSS tool to test for significant difference among fungicides (F), concentrations (C) and their interactions (F×C). In the study, observed significant differences at 1% level of significance (P value > 0.01) for mycelial growth inhibition at different fungicides and concentrations. The poisoned food technique was followed to evaluate the efficacy of fungicides in inhibiting the growth of mycelium of *C. capsici*. The PDA medium was prepared and autoclaved at 121°C for 20 minutes. The sterilized medium was cooled, the fungicide was added to the melted media to obtain the required concentrations. About 15-20 ml of poisoned medium was poured in each sterilized Petri plates. Suitable check (Control) was maintained without addition of fungicides. Eight mm mycelial disc was taken from the periphery of the colony and placed in the centre of Petri plate and incubated at 28 ± 1 °C. Three replications were maintained for each treatment. The diameter of the colony was measured after reaching complete growth in control plates.

The per cent growth inhibition was calculated by using the formula given by Vincent (1947) as follows;

$$I = \frac{C-T}{C} \times 100$$

Where, I = Per cent inhibition of mycelial growth.
C = Growth of mycelium in control.
T = Growth of mycelium in treatment.

Results and Discussion

Disease management involves use of resistant cultivars, fungicide spray at appropriate time. Association of multiple species of *Colletotrichum* with chilli anthracnose is making breeding for resistance difficult. Thus, the necessity of evaluation of fungicides under *in vitro* conditions will serve as preliminary study before field trails. Therefore, in the present study efficacy of fungicides was tested with five contact, systemic and combi fungicides at three different concentrations as mentioned in the Materials and methods and the data is presented in Table 1, 2 and 3; Figure 1, 2 and 3.

Among the contact fungicides tested, mancozeb 75% WP recorded 100 percent mycelial inhibition at all three concentrations which was significantly superior. The least mycelial inhibition was recorded in zineb 75% WP (30.14 %) significantly lowest when compared to other fungicides. Among the concen-

trations, the highest per cent mycelial inhibition of 75.31 per cent was recorded at 0.3 per cent. In case of interaction effect of fungicides and concentrations, the maximum inhibition of 100 per cent was in mancozeb 75% WP at all concentrations and in propineb 70 WP at 0.3 % concentration whereas, least mycelial inhibition of 17.64 per cent was in zineb 75% WP at 0.1 per cent (Table 1 and Figure 1).

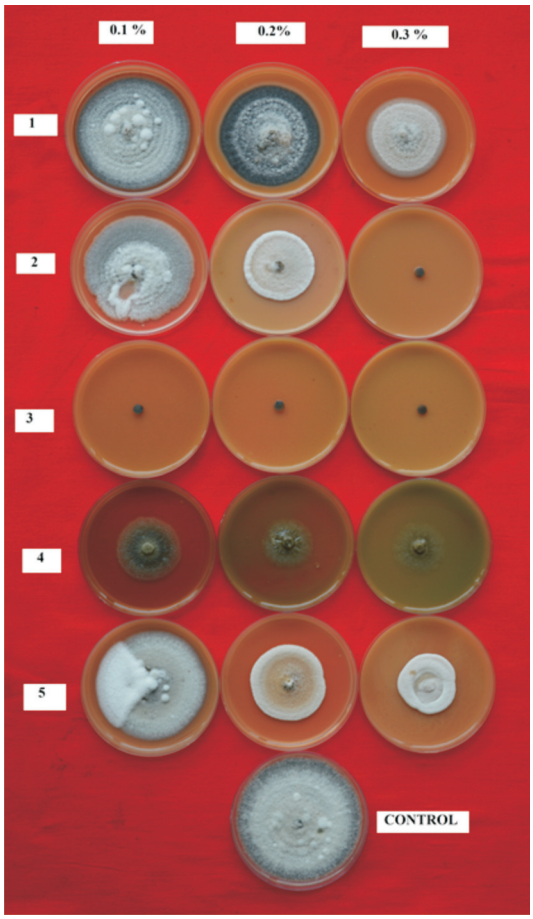

Fig. 1. *In vitro* evaluation of contact fungicides against *Colletotrichum capsici*

The five systemic fungicides tested, among which propiconazole 25% EC and difenoconazole 25% EC showed 100 per cent mycelial inhibition, least mycelial inhibition was in hexaconazole 5% EC with 66.11 per cent. Among the three different concentrations, highest mycelial inhibition of 95.47 per cent was recorded in 0.10 per cent. In case of interaction, lowest mycelial inhibition of 48.47per cent was in tricyclazole 75% WP at 0.025 per cent whereas, the complete inhibition was in tricyclazole 75% WP, tebuconazole 250 EC at 0.05 % and 0.10 % concentrations respectively. Propiconazole 25% EC and difenoconazole 25% EC at all concentrations showed complete inhibition (Table 2 and Figure 2).

Among the combi product fungicides tested, metalaxyl 8% + mancozeb 64% WP showed cent per cent inhibition and lowest inhibition was in tebuconazole 50% + trifloxystrobin 25% with 72.36 per cent. In case of interaction effect, tebuconazole 50% + trifloxystrobin 25% at 0.1 per cent recorded lowest of 66.25 per cent of mycelial inhibition and among the different concentrations 0.3 per cent recorded highest inhibition of 95.56 per cent (Table 3 and Figure 3).

Different fungicides showed varied efficacy to inhibit the growth of *C. capsici* under study.The growth inhibition per cent showed positive correlation with increase in concentration of the fungicides.The similar results were presented by Patel *et al.* (2022) who evaluated contact, systemic and combi fungicides against *C. capsici*. Among the contact fungicides, copper oxychloride 50WP re-

Table 1. Efficacy of contact fungicides on inhibition of mycelial growth of *Colletotrichum capsici*

Sl. No.	Contact fungicides	Per cent mycelial inhibition			Mean
		0.10%	0.20%	0.30%	
1	Zineb 75% WP(Indofil Z78)	17.64(24.79)*	25.83(30.53)*	46.94(43.25)*	30.14(32.86)*
2	Propineb 70% WP (Antracol)	25.83(30.53)	51.39(45.80)	100.00(90.00)	59.07(55.44)
3	Mancozeb 75% WP (Indofil M45)	100.00(90.00)	100.00(90.00)	100.00(90.00)	100.00(90.00)
4	Copper oxy chloride 50% WP (Blitox 50 W)	60.28(50.95)	64.17(53.24)	65.69(54.18)	63.38(52.79)
5	Chlorothalonil 75% WP (Kavach)	28.61(32.33)	46.11(42.76)	63.89(53.08)	46.20(42.72)
	Mean	46.47(45.72)	57.50(52.47)	75.31(66.10)	59.76(54.76)
		S. Em.±	C. D.		
	Fungicides (F)	0.540	1.542		
	Concentration (C)	0.418	1.194		
	Fungicides × Concentration (F×C)	0.935	2.671		

* Arc sin transformed values

corded highest inhibition of 95.83 per cent followed by mancozeb 75 WP (84.56 %) whereas, among the systemic fungicides tested propiconazole 25 EC showed highest mycelial inhibition of 91.19 per cent followed by difenconazole 25 EC (89.01 %).The triazoles involve in the interruption of the conver-

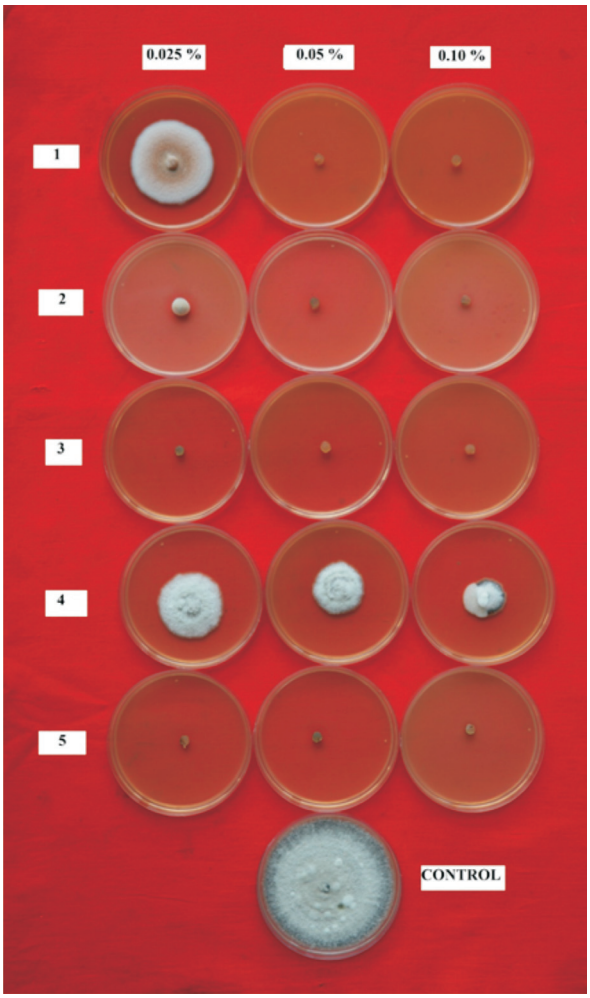

Fig. 2. *In vitro* evaluation of systemic fungicides against *Colletotrichum capsici*

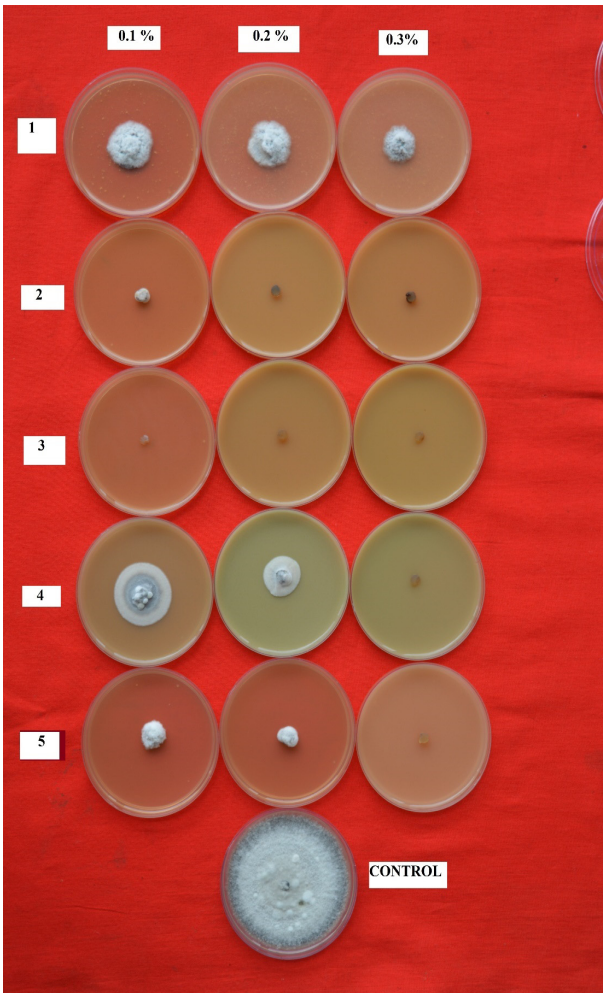

Fig. 3. *In vitro* evaluation of combi product fungicides against *Colletotrichum capsici*

Table 2. Efficacy of systemic fungicides on inhibition of mycelial growth of *Colletotrichum capsici*

Sl. No.	Systemicfungicides	Per cent mycelial inhibition			Mean
		0.025%	0.05%	0.10%	
1	Tricyclazole 75% WP(Beam)	48.47(44.12)*	100.00(90.00)*	100.00(90.00)*	82.82(74.71)*
2	Tebuconazole 250 EC (Folicur)	89.58(71.24)	100.00(90.00)	100.00(90.00)	96.53(83.75)
3	Propiconazole 25% EC (Tilt)	100.00(90.00)	100.00(90.00)	100.00(90.00)	100.00(90.00)
4	Hexaconazole 5% EC (Contaf)	52.08(46.19)	68.89(56.17)	77.36(61.65)	66.11(54.67)
5	Difenconozole 25% EC (Score)	100.00(90.00)	100.00(90.00)	100.00(90.00)	100.00(90.00)
	Mean	78.03(68.31)	93.78(83.23)	95.47(84.33)	89.09(78.62)
		S. Em. ±	C. D.		
Fungicides (F)		0.405	1.158		
Concentration (C)		0.314	0.897		
Fungicides × Concentration (F×C)		0.702	2.006		

* Arc sin transformed values

sion of lanosterol to ergosterol *via* binding to fungal cytochrome P-450 and subsequent disruption of fungal membranes. Similar results have been presented by Katediya *et al.* (2019) who reported that propiconazole recorded maximum inhibition of 69.58 per cent and among combi product carbendazim 12%+ mancozeb 64% WP and captan 70% + hexaconazole 5% WP showed highest inhibition of 89.39 per cent. The similar results were reported by Vani and Somashekhara (2018).

On the basis of the above results, it can be concluded that among the fungicides, systemic group comprising triazoles are highly effective in inhibiting the mycelial growth even at low concentration. Thus, these group can be effectively used in field conditions.

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Conflict of Interest

Authors do not have any conflict of interest

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