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Efficacy of Fungicides against *Colletotrichum lindemuthianum* (Sacc. & Magn.) Bri. & Cav. causing Anthracnose of French Bean

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A B S T R A C T

The present *in vitro* study was carried out at the Department of Plant Pathology, University of Agricultural Sciences, Dharwad, Karnataka, India to evaluate the efficacy of different fungicides against *Colletotrichum lindemuthianum* (Sacc. & Magn.) Bri. & Cav. causing anthracnose of french bean using poisoned food technique. Among the contact fungicides tested, mancozeb and copper oxy chloride showed cent percent inhibition of mycelial growth (1000, 2000 and 3000 ppm) and was significantly superior over all other treatments. Carbendazim, thiophinate methyl, propiconazole and tebuconazole (systemic fungicides) recorded complete (100 %) inhibition of mycelial growth of *C. lindemuthianum*at 500, 1000 and 1500 ppm. Cent percent mycelial inhibition was recorded by combi product fungicides viz., (carbendazim + mancozeb), (tricyclazole + mancozeb) and (carboxin + thiram) followed by 88.9 per cent in (captan + Hexaconazole) at 500, 1000 and 2000 ppm.

Introduction

French bean (*Phaseolus vulgaris* L.) is an important legume vegetable grown throughout the world. It belongs to family Leguminaceae and is originated from central America and north America. It is popularly called as kidney bean, haricot bean, snap bean and navy bean. It is rich source of protein, vitamins and minerals. It is used as vegetable (fresh beans), shelled green beans and dried seeds (Rajmah) as pulse. In India, french bean is being grown in 2.28 lakh ha area with 22.77 lakh MT production and 9.98 MT/ha productivity. Major growing states are Gujarat, Andhra Pradesh, Karnataka and Odissa. Production of french beans in Karnataka is 153.85 thousand MT (Anon., 2019).

Colletotrichum lindemuthianum (Sacc. & Magn.) Bri. & Cav.is a destructive fungal seed borne pathogen causing anthracnose of french bean. The pathogen occurs globally and develops relatively well in cool and humid conditions (Leitich *et al.*, 2016). The pathogen affects all the above ground portion *viz.*, leaves, petioles, pods and also seeds. The

pathogen is highly viable, more than 100 pathogenic variants and races were reported (Katungi *et al.,* 2009).The disease could be devastating causing upto 100 per cent yield loss (Mohammed, 2013).

Fungicides are still a key player in plant disease management. New chemicals are constantly synthesized as extensive cropping demands quick and economical control of plant diseases.

In vitro evaluation of fungicides against the pathogen reveals the effectiveness of fungicide in disease management. Timely use of correct fungicides in proper dose significantly reduces the disease severity and yield losses.

Materials and Methods

In vitro evaluation of fungicides

Five contact, six systemic fungicides and five combi products were tested against *C. lindemuthianum* under *in vitro* conditions using poisoned food technique (Sharvelle, 1961). The contact fungicides were evaluated at 1000, 2000 and 3000 ppm concentrations. The systemic fungicides were evaluated at 500, 1000 and 1500 ppm concentrations where as combi products were evaluated at 500, 1000 and 2000 ppm.

Fungicide suspension was prepared by adding required quantity of fungicide in molten and cooled PDA medium to obtain the desired concentration. Twenty ml of poisoned medium was poured in each of the sterilized Petri plates.

Mycelial disc of 0.5 cm was taken from the periphery of the culture and placed in the centre and incubated at 25 ± 2 ºC till growth of the fungus touched the periphery in control plate. Suitable checks were also maintained without addition of any fungicide. Three replications were maintained for each treatment. The diameter of the colony was measured in two directions and average was worked out. The per cent inhibition of growth was worked out.

The per cent inhibition of growth was calculated by using the formula given by Vincent (1947).

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

Where,

I = Inhibition of mycelial growth (%)
C = Radial growth of mycelium in control (cm).
T = Radial growth of mycelium in treatment (cm).

List of fungicides used for *in vitro* evaluation

Contact fungicides

Sl. No.	Common name	Trade name
1	Captan 50 % WP	Captaf
2	Chlorothalonil 75 % WP	Kavach
3	Copper oxychloride 50 % WP	Blitox
4	Mancozeb 75 % WP	Dithane M-45
5	Propineb 70 % WP	Antracol

Systemic fungicides

Sl. No.	Common name	Trade name
1	Carbendazim 50 % WP	Bavistin
2	Difenoconazole 25 % EC	Score
3	Hexaconazole 5 % EC	Contaf
4	Propiconazole 25 % EC	Tilt
5	Tebuconazole 250 EC	Folicur
6	Thiophanate methyl 70 % WP	Roko

Combi product fungicides

Sl. No.	Common name	Trade name
1	Captan 70 % + hexaconazole 5 % WP	Taqat
2	Carbendazim 12 % + mancozeb 63 % WP	Saaf
3	Tebuconazole 50 % + trifloxystrobin 25 % WG	Nativo
4	Thiram 37.5 % + carboxin 37.5 % WP	Vitavax power
5	Tricyclazole 18 % + mancozeb 62 % WP	Merger

Results and Discussion

Contact fungicides

All the fungicides were significantly superior over control with respect to per cent mycelial inhibition. Among the five contact fungicides tested, mancozeb and copper oxy chloride recorded cent percent inhibition of mycelial growth and significantly superior over all other treatments. Next best treatment was propineb (58.52 %) and captan (45.06 %) which was on par with each other. The least mycelial inhibition was observed in case of chlorothalonil (6.79 %). The results are presented in Table 1 and Plate 1. Mancozeb when dissolved in water, react to form active toxicant which is believed to interfere with sulphydryl group of enzymes in fungal cell cytoplasm and mitochondria (Gullino *et al.*, 2010).

Systemic fungicides

Among the six systemic fungicides tested carbendazim, thiophinate methyl, propiconazole and tebuconazole recorded complete (100 %) inhibition of mycelial growth at all concentrations tested and was significantly superior to all other treatments. Least inhibition of 33.33 per cent was recorded in hexaconozole (Table 2 and Plate 2). The triazole fungicide leads to demethylation of C14 during ergosterol biosynthesis there by leading to C14 metyl sterols accumulation. Ergosterol biosynthesis is essential for fungal cell wall formation. Hence, lack of ergosterol production hinders development of fungus. The results are in agreement withGopinath *et al.*, (2006).

Combi product fungicides

(Carbendazim + mancozeb), (tricyclazole + mancozeb) and (carboxin + thiram) recorded cent per cent inhibition of mycelial growth among the combi product fungicides tested at all the concentrations. Least inhibition of 74.07 per cent was observed in (trifloxystrobin + tebuconazole).The results are depicted in Table 3 and Plate 3. The effectiveness of combi product (carbendazim

+ mancozeb) is due to both contact and systemic effect of the fungicide. Mancozeb cause disruption in enzyme activity of fungus while carbendazim inhibit fungal microtubule formation there by effecting growth of fungal mycelium and germtube. Similar results were recorded byChaudhari and Gohel (2016).

Table.1 *In vitro* evaluation of contact fungicides against *Colletotrichum lindemuthianum*

Contact fungicides	Inhibition of mycelial growth (%)			
	Concentrations(ppm)			Mean
	1000	2000	3000	
Captan 50 % WP	37.04 (37.47)*	46.30 (42.86)	51.85 (46.04)	45.06 (42.15)
Chlorothalonil 75 % WP	1.11 (6.05)	4.44 (12.17)	14.81 (22.63)	6.79 (15.10)
Copper oxy chloride 50 % WP	100 (89.96)	100 (89.96)	100 (89.96)	100 (89.96)
Mancozeb 75 % WP	100 (89.96)	100 (89.96)	100 (89.96)	100 (89.96)
Propineb 70 % WP	27.78 (31.79)	47.78 (43.71)	100.00 (89.96)	58.52 (49.88)
Mean	53.19 (46.81)	59.70 (50.57)	73.33 (58.89)	
	Fungicide (F)	**Concentration (C)**	**F×C**	
S. Em. ±	1.31	1.01	2.27	
CD(0.01)	5.07	3.93	8.78	

*****Arcsine transformed values

Table.2 *In vitro* evaluation of systemic fungicides against *Colletotrichum lindemuthianum*

Systemic fungicides	Inhibition of mycelial growth (%)			
	Concentrations (ppm)			Mean
	500	1000	1500	
Carbendazim 50 % WP	100 (89.96)*	100 (89.96)	100 (89.96)	100 (89.96)
Difenoconazole 25 % EC	74.07 (59.37)	75.93 (60.59)	85.19 (67.34)	78.40 (62.28)
Hexaconazole 5 % EC	22.22 (28.11)	24.07 (29.37)	53.70 (47.11)	33.33 (35.25)
Propiconazole 25 % EC	100 (89.96)	100 (89.96)	100 (89.96)	100 (89.96)
Tebuconazole 250 EC	100 (89.96)	100 (89.96)	100 (89.96)	100 (89.96)
Thiophanate methyl 70 % WP	100 (89.96)	100 (89.96)	100 (89.96)	100 (89.96)
Mean	82.72 (65.41)	83.33 (65.88)	89.81 (71.36)	
	Fungicide (F)	**Concentration (C)**	**F×C**	
S. Em. ±	0.48	0.34	0.83	
CD(0.01)	1.83	1.29	3.17	

*****Arcsine transformed values

Table.3 *In vitro* evaluation of combi product fungicides against *Colletotrichum lindemuthianum*

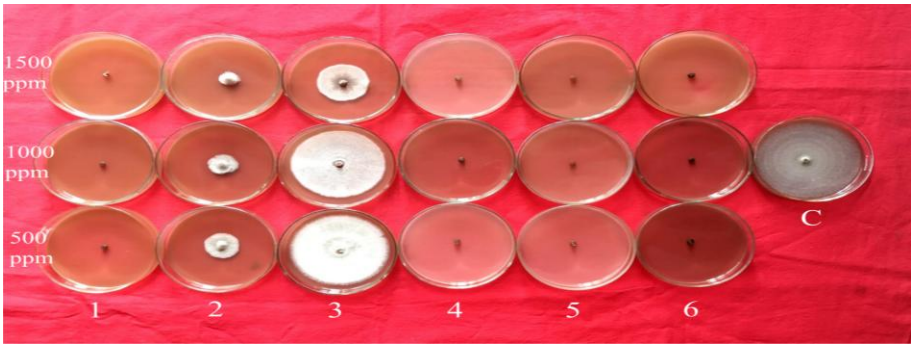
Combi product fungicides	Inhibition of mycelial growth (%)			
	Concentrations (ppm)			Mean
	500	1000	2000	
(Captan 70 % + Hexaconazole 5 %) WP	79.63 (63.15)*	87.04 (68.87)	100.00 (89.96)	88.89 (70.50)
(Carbendazim 12 % + Mancozeb 63 %) WP	100.00 (89.96)	100.00 (89.96)	100.00 (89.96)	100.00 (89.96)
(Carboxin 37.5 % + Thiram 37.5 %) WP	100.00 (89.96)	100.00 (89.96)	100.00 (89.96)	100.00 (89.96)
(Tricyclazole 18 % + Mancozeb 62 %) WP	100.00 (89.96)	100.00 (89.96)	100.00 (89.96)	100.00 (89.96)
(Trifloxystrobin 25 % +Tebuconazole 50 %) WG	68.52 (55.85)	75.93 (60.59)	77.78 (61.85)	74.07 (59.37)
Mean	89.63 (71.19)	92.59 (74.18)	95.56 (77.80)	92.59 (74.18)
	Fungicide (F)	Concentration (C)	F×C	
S. Em. ±	0.59	0.46	1.02	
CD(0.01)	2.29	1.77	3.97	

*****Arcsine transformed values

Plate.1 *In vitro* evaluation of contact fungicides against *Colletotrichum lindemuthianum*

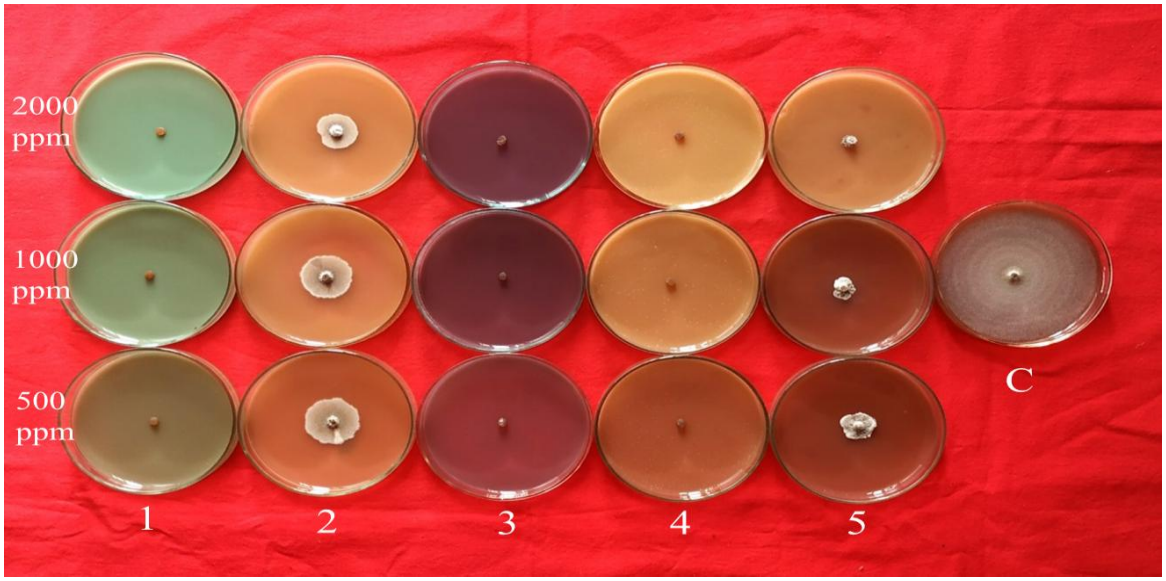
1) Mancozeb 2) Captan 3) Propineb 4) Chlorothalonil5) Copper oxychloride C) Control

Plate.2 *In vitro* evaluation of systemic fungicides against *Colletotrichum lindemuthianum*



1) Propiconazole2) Difenoconazole 3) Hexaconazole4) Carbendazim 5)Tebuconazole 6) Thiophanate methyl C) Control

Plate.3 *In vitro* evaluation of combi product fungicides against *Colletotrichum lindemuthianum*



1) Carbendazim + Mancozeb 2) Trifloxystrobin + Tebuconazole 3) Carboxin + Thiram
4) Tricyclazole + Mancozeb5) Captan + Hexaconazole C) Control

The results are in agreement with Rajesha *et al.,* (2010). They reported Mancozeb was cent per cent effective contact fungicide against *C. lindemuthianum* causing anthracnose of dolichos beans at 800 ppm. Carbendazim was highly effective systemic fungicide with 100 per cent mycelial growth inhibition at 50 ppm. These results are also coincides with Marak*et al.,* (2020). Manjunath *et al.,* (2013) reported that cent percent inhibition of mycelial growth of *C. lindemuthianum* by carbendazim and carbendazim + mancozeb at 100, 250, 500 and 750 ppm concentrations.

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