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Efficacy of Fungicides Against *Rhizoctonia solani* (J. G. Kuhn) Causing Root Rot of French Bean

Tharana Poonacha T., Farooq Khan, Yashoda R. Hegde, Nithya S. R., Ismayil M. M. S.

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ABSTRACT

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 various fungicides against *Rhizoctonia solani* (J. G. Kuhn) causing root rot of french bean using poisoned food technique. Among the contact fungicides tested, captan (70.37 %) and chlorothalonil (69.63 %) recorded maximum percent inhibition of mycelial growth and significantly superior over all other treatments. Carbendazim, difenoconazole, hexaconazole, propiconazole and tebuconazole (systemic fungicides) recorded cent per cent inhibition of mycelial growth of *Rhizoctonia solani*. Cent percent mycelial inhibition was recorded in all the combi product fungicides *viz*., (carbendazim + mancozeb), (trifloxystrobin + tebuconazole), (tricyclazole + mancozeb), (captan 70 % + hexaconazole 5 %) and (carboxin + thiram) at all the concentrations.

Keywords French bean, Root rot, *Rhizoctonia solani*, Fungicides.

INTRODUCTION

French bean (*Phaseolus vulgaris* L.) belonging to Leguminaceae family is an important legume vegetable grown across the world. It is known to be originated from central America and north America. It is also known as kidney bean, haricot bean, snap bean and navy bean. As french bean is early maturing and rich source of protein, vitamins and minerals, it is regarded to be the best crop to be grown in developing and underdeveloped countries to meet the nutritional requirements of the people. 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).

Tharana Poonacha T.[1], Farooq Khan[2*], Yashoda R. Hegde[3], Nithya S. R[4]., Ismayil M. M. S[5].

[1,2,5]PhD scholar, [3]Professor
[1,2,3,4]Department of Plant Pathology, College of Agriculture, University of Agricultural Sciences, Dharwad, 580005, Karnataka, India

[5]Department of Plant Pathology, College of Agriculture, GKVK, Bangalore 560065, India

Email: farooqkhanf30085@gmail.com
*Corresponding author

Rhizoctonia solani (J. G. Kuhn) is an important fungal pathogen causing root rot of french bean. It is known to be pathogenic on both shoot and root. It is a soil borne pathogen with wide host range and occur worldwide (Torres *et al*. 2016). It survives saprobically in soil due to its facultative parasitic ability. The disease occurs in all the stages of crop in field conditions. Godoy-Lutz *et al*. (2008) reported shoot infection of *Rhizoctonia solani* causing web blight in humid low land tropics of Central America and the Caribbean. Infected seeds also help in survival and dispersion of the pathogen also leading to poor crop stand when sown.

Fungicides continue to be an important tool for managing plant diseases. Amidst the wide and diverse range of fungicides available in the market, it is important to test the effectiveness of prevalent fungicides against the prevalent pathogen under lab and field conditions. *In vitro* studies are must to known the efficacy of different fungicides and deduce their dosages to manage the disease effectively.

MATERIALS AND METHODS

In vitro evaluation of fungicides

Five contact, six systemic fungicides and five combi products were tested against *R. solani* 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 center 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

Among the five contact fungicides tested, captan (70.37 %) and chlorothalonil (69.63 %) recorded maximum percent inhibition of mycelial growth and significantly superior over all other treatments. Next

Table 1. *In vitro* evaluation of contact fungicides against *Rhizoctonia solani.*

Contact fungicides	Inhibition of mycelial growth (%)			
	Concentration (ppm)			Mean
	1000	2000	3000	
Captan 50 % WP	55.56	69.26	86.30	70.37
	(48.17)	(56.30)	(68.25)	(57.00)
Chlorothalonil 75 % WP	53.70	71.11	84.07	69.63
	(47.11)	(57.46)	(66.45)	(56.54)
Copper oxy chloride 50 % WP	0.00	3.70	37.04	13.58
	(0.00)	(11.09)	(37.47)	(21.62)
Mancozeb 75 % WP	38.89	48.89	60.37	49.38
	(38.56)	(44.35)	(50.96)	(44.63)
Propineb 70 % WP	6.67	9.26	34.44	16.79
	(14.96)	(17.71)	(35.92)	(24.18)
Mean	30.96	40.44	69.63	
	(33.8)	(39.48)	(56.54)	
	Fungicide (F)	Concentration (C)	F×C	
SEm ±	2.60	2.01	4.50	
CD (0.01)	10.05	7.79	17.41	

* Arcsine transformed values.

Table 2. *In vitro* evaluation of systemic fungicides against *Rhizoctonia solani.*

Systemic fungicides	Inhibition of mycelial growth (%)			
	Concentration (ppm)			Mean
	500	1000	1500	
Carbendazim 50 % WP	100	100	100	100
	(89.96)*	(89.96)	(89.96)	(89.96)
Difenoconazole 25 % EC	100	100	100	100
	(89.96)*	(89.96)	(89.96)	(89.96)
Hexaconazole 5 % EC	100	100	100	100
	(89.96)*	(89.96)	(89.96)	(89.96)
Propiconazole 25 % EC	100	100	100	100
	(89.96)	(89.96)	(89.96)	(89.96)
Tebuconazole 250 EC	100	100	100	100
	(89.96)	(89.96)	(89.96)	(89.96)
Thiophanate methyl 70 % WP	40.74	44.44	57.41	47.53
	(39.65)	(41.79)	(49.24)	(43.57)
Mean	90.12	90.74	92.90	
	(71.65)	(72.26)	(74.52)	
	Fungicide (F)	Concentration (C)	F×C	
SEm ±	0.52	0.37	0.91	
CD (0.01)	2.01	1.42	3.47	

* Arcsine transformed values.

best treatment was mancozeb with 49.38 % inhibition of mycelial growth. The least mycelial inhibition was observed in case of copper oxy chloride (13.58 %). All the fungicides were significantly superior over control with respect to per cent mycelial inhibition. The results are presented in Table 1 and Plate 1.

Plate 1. *In vitro* evaluation of contact fungicides against *Rhizoctonia solani.*
1) Mancozeb 2) Captan 3) Propineb 4) Chlorothalonil 5) Copper oxy chloride.

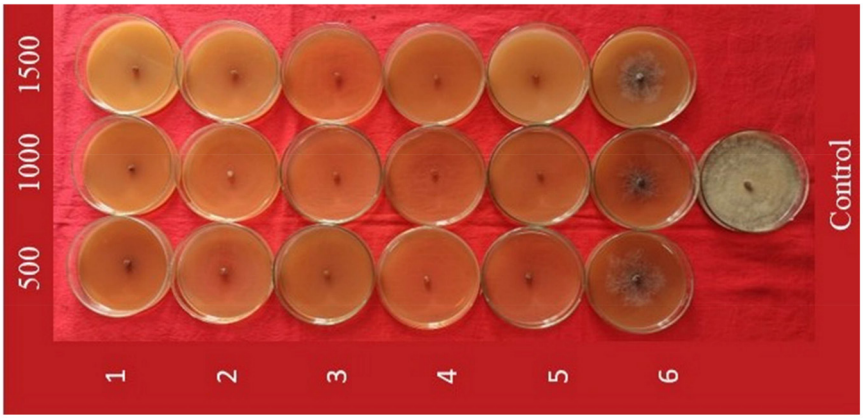

Plate 2. *In vitro* evaluation of systemic fungicides against *Rhizoctonia solani.*
1) Propiconazole 2) Difenoconazole 3) Hexaconazole 4) Carbendazim 5) Tebuconazole 6) Thiophanate methyl.

Similar results are obtained by Bohra *et al*. (2018) in cluster bean. Captan (phthalimide fungicide) and Chlorothalonil (phthalonitrile fungicide) can block the transformation of alternative special structure of glutathione and reduce enzymes activities which used special conformation of glutathione as their reaction centers (Yang *et al*. 2011).

Systemic fungicides

Among the six systemic fungicides tested carbendazim, difenoconazole, hexaconazole, propiconazole and tebuconazole recorded complete (100 %) inhibition of mycelial growth at all concentrations tested and was significantly superior to thiophinate methyl. Negative results with 33.33% inhibition of mycelial growth was recorded in thiophinate methyl (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 devel-

Plate 3. *In vitro* evaluation of combi product fungicides against *Rhizoctonia solani.*
1) Carbendazim + Mancozeb 2) Trifloxystrobin + Tebuconazole 3) Carboxin + Thiram
4) Tricyclazole + Mancozeb 5) Captan + Hexaconazole.

Table 3. *In vitro* evaluation of combi product fungicides against *Rhizoctonia solani.*

Combi product fungicides	Inhibition of mycelial growth (%)			
	Concentration (ppm)			Mean
	500	1000	2000	
(Captan 70 % + Hexaconazole 5 %) WP	100	100	100	100
	(89.96)	(89.96)	(89.96)	(89.96)
(Carbendazim 12 % + Mancozeb 63 %) WP	100	100	100	100
	(89.96)	(89.96)	(89.96)	(89.96)
(Carboxin 37.5 % + Thiram 37.5 %) WP	100	100	100	100
	(89.96)	(89.96)	(89.96)	(89.96)
(Tricyclazole 18 % + Mancozeb 62 %) WP	100	100	100	100
	(89.96)	(89.96)	(89.96)	(89.96)
(Trifloxystrobin 25 % +Tebuconazole 50 %) WG	100	100	100	100
	(89.96)	(89.96)	(89.96)	(89.96)
Mean	100	100	100	
	(89.96)	(89.96)	(89.96)	
	Fungicide (F)	Concentration (C)	F×C	
SEm ±				
CD (0.01)				

opment of fungus. The results are in agreement with Kumar *et al*. (2017) in rice.

Combi product fungicides

All the combi product fungicide viz., (carbendazim + mancozeb), (trifloxystrobin + tebuconazole), (tricyclazole + mancozeb), (captan 70 % + hexaconazole 5 %) and (carboxin + thiram) recorded cent per cent inhibition of mycelial growth at all the concentrations (Table 3 and Plate 3). Similar results were recorded by Persaud *et al*. (2019). The combined effectiveness of both contact and systemic fungicides in combi product fungicides leads to the complete inhibition of mycelial growth of the pathogen.

The results were in agreement with Manu *et al*. (2012) in finger millet against *Sclerotium rolfsii* and Meena *et al*. (2018) in mung bean against *R. solani.* They reported the systemic fungicides like hexaconazole, propiconazole, difenconazole and combi products, (hexaconazole 4% + zineb 68%), (tebuconazole 50% + trifloxystrobin 25%) and (thiram 37.5% + carboxin 37.5%) showed complete inhibition of both pathogens at all the concentrations tested.

CONCLUSION

The *Rhizoctonia solani* causes both root rot and web blight causing considerable yield loss. Among the different contact fungicide tested captan (70.37 %) and chlorothalonil (69.63 %) recorded maximum percent inhibition of mycelial growth whereas, all systemic fungicide produced cent per cent inhibition except thiophanate methyl. The combi products were highly effective (100%) in inhibition of mycelial growth under *in vitro* conditions.

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