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EFFICACY OF DIFFERENT FUNGICIDES AGAINST *FUSARIUM SOLANI CAUSING* CORIANDER ROOT ROT

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ABSTRACT
Different contact, systemic and combination of fungicides were evaluated *in vitro* against *Fusarium solani*. Amongst contact (non systemic) fungicides evaluated maximum inhibition in mycelial growth was observed in mancozeb (100%) and zineb (100%) followed by chlorothalonil (72.52%). Among the different concentrations tried, Mancozeb and Zineb gave 100% inhibition at all concentration, while chlorothalonil gave 80.28% growth inhibition followed by copper oxychloride (79.25%) at 2500 ppm concentration. Out of six systemic fungicides, carbendazim found best with 98.68% mycelial growth inhibition followed by propiconazole (85.27%) and difenoconazole (75.53%). Carbendazim showed complete inhibition of mycelial growth of the test fungus at 500 ppm concentration followed by same fungicide with 250 ppm (99.46%) and 100 ppm (98.12%). Among the fungicides combination, cymoxanil + mancozeb, carbendazim + mancozeb and Tricyclazole + mancozeb gave 100% growth inhibition at all concentration followed by carboxin + thirum with 98.79% mean growth inhibition while least inhibition was observed in Zineb + Hexaconazol (72.19%).

INTRODUCTION

Coriander (*Coriandrum sativum* L.) is an important spice cum vegetable crop, often referred to as Dhania or Dhana. Coriander cultivation has existed for several hundred years as a sustainable form of agriculture in India and in many other countries. It is an annual herbaceous vegetable and spice grown in both tropical and sub-tropical regions. This crop is a significant source of income, making India the world's single largest producer and exporter to the USA, UK, Canada, Saudi Arabia, Singapore, Malaysia, Germany and many more countries across the world. Coriander is affected by many diseases like as; stem gall, powdery mildew, wilt and stem rot (Lakra, 2001). Among all diseases, root rot caused by *Fusarium solani* is a major problem in India and one of the more significant economic constraints to coriander production worldwide, especially in tropical and sub tropical regions.The root rot observed in scattered pockets within a field. The natural incidence of root rot was noticed before seed setting.This disease cause yellowing of leaves followed by discolouration and drying. The tap root of affected plants showed a reddish brown discoloration that later becomes darker and larger. The discoloration was evident on the tap root and the stem below the soil line without a definite margin or it may appear as streaks extending up to the soil line. Longitudinal cracks were appeared along with the bark shredding of main root, whereas small and lateral roots were killed. (Jensen *et al.,* 2009). Root system was adversely affected. The attacked plants in most of the cases die within a very short time. (Madia *et al.*, 1999). Economic losses caused by the disease are mainly attributed to lower quality and marketability. Several workers have attempted to control *F. solani* by use of different systemic fungicides (Bhat and Srivastava, 2003; Rawal and Thakore, 2003; Bhanumathi and Rai, 2007; and Soni and Verma, 2010), contact fungicides (Vadhera *et al.*, 1997 and Singh *et al.*, 2000) and fungicides combination (El Habbaa *et al.,* 2002; Chavan *et al.,* 2009).

The main objective of this study was to evaluate the different fungicides at different concentrations for their efficacy against mycelial growth inhibition of *F. solani* under *in vitro* condition.

MATERIALS AND METHODS

Efficacy of different contact, systemic and combination of fungicides at different concentrations was evaluated on radial growth of test fungus by Poisoned Food Technique (Nene, 1971).

In vitro evaluation of fungicides

Six systemic fungicides viz. carbendazim, difenoconazole, tricyclazole, hexaconazole, mycobutanil and propiconazole were tested at concentration of 50, 100, 250, 500 ppm. Five non-systemic fungicides viz. mancozeb, copper oxychloride, sulphur, chlorothalonil, zineb were tested at concentration of 1000, 1500, 2000, 2500 ppm. The six combination products of fungicides viz. Zineb + hexaconazole, carbendazim + copper oxychloride, cymoxanil + mancozeb, carbendazim + mancozeb, Tricyclazole + mancozeb and carboxin + thirum were tested at concentration of 500, 1000, 1500, 2000 ppm against test fungus.

Stock solutions of the fungicides were prepared in sterile distilled water and added aseptically to sterilized PDA medium to get the required concentrations and then poured into petriplates. The plates prepared without any fungicides served as control. These plates were inoculated with 7 mm disc of

Table 1: Growth inhibition of *F. solani* at different concentrations of various systemic fungicides after seven days of incubation at 28 ± 2° C

Fungicide	Concentration (ppm)/Per cent inhibition*				Mean	Toxicity Index#
	50	100	250	500		
Carbendazim	97.13	98.12	99.46	100	98.68	394.72
Propiconazole	78.82	82.58	88.22	91.45	85.27	341.08
Difenoconazole	69.46	73.03	78.61	81.04	75.53	302.12
Hexaconazole	69.04	71.81	74.03	77.33	73.05	292.20
Mycobutanil	51.29	57.91	63.98	70.71	60.97	243.88
Tricyclazole	6.57	27.12	50.12	58.04	35.46	141.84
Control	0.00	0.00	0.00	0.00	0.00	0.00
	Fungicides (F)		Concentration (C)		F×C	
S.Em.+	0.36		0.29		0.71	
C.D. at 5%	0.99		0.81		1.99	

* Mean of four replications # Maximum toxicity index = 400.00

Table 2: Growth inhibition of *F. solani*at different concentrations of various contact (non systemic) fungicides after seven days of incubation at 28+ 2°C

Fungicide	Concentration (ppm)/Per cent inhibition*				Mean	Toxicity Index#
	1000	1500	2000	2500		
Mancozeb	100	100	100	100	100	400.00
Zineb	100	100	100	100	100	400.00
Chlorothalonil	63.67	69.16	76.99	80.28	72.52	290.08
Copper oxychloride	59.89	67.71	73.01	79.25	69.96	279.84
Sulphur	23.38	49.65	59.87	63.31	49.05	196.20
Control	0.00	0.00	0.00	0.00	0.00	0.00
	Fungicides (F)		Concentration (C)		F×C	
S.Em.+	0.32		0.28		0.64	
C.D. at 5%	0.89		0.79		1.78	

*Mean of four replications # Maximum toxicity index = 400.00

Table 3: Growth inhibition of *F. solani* at different concentrations of various combinations of fungicides after seven days of incubation at 28 ± 2° C

Fungicide	Concentration (ppm)/ Per cent inhibition*				Mean	Toxicity Index#
	500	1000	1500	2000		
Cymoxanil + Mancozeb	100	100	100	100	100	400
Carbendazim + Mancozeb	100	100	100	100	100	400
Tricyclazole+ Mancozeb	100	100	100	100	100	400
Carboxin + Thirum	97.83	98.18	99.32	99.85	98.79	395.16
Carbendazim +Copper oxycloride	67.89	73.55	77.82	81.40	75.17	300.68
Zineb + Hexaconazol	65.89	69.91	74.45	78.70	72.19	288.76
Control	0.00	0.00	0.00	0.00	0.00	0.00
	Fungicides (F)		Concentration (C)		F×C	
S.Em.+	0.28		0.23		0.56	
C.D. at 5%	0.78		0.64		1.57	

*Mean of four replications # Maximum toxicity index = 400.00

seven day old culture of the test fungus and incubated at 28 ± 2°C for 7 days(Nene and Thapliyal, 1993). After 7 days of incubation the radial growth was measured. The percent inhibition in growth was determined with the help of mean colony diameter and calculated by using the formula given by McKinney (1923).

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

Where,

PGI = per cent growth inhibition index

C = area of test fungus in control (mm^2),

T = area of test fungus in respective treatment (mm^2)

RESULTS AND DISCUSSION

The growth inhibition of *Fusarium solani* causing root rot in coriander has been tested at various concentration of systemic, non-systemic and combination of fungicides *in vitro* recorded in Table 1-3. The perusal of results showed that (Table 1) all the systemic fungicides were effective and gave more than 51 per cent inhibition growth of test fungus at 50 ppm concentration as compared to control except Tricyclazole which gave only 6.57 per cent inhibition. Carbendazim gave cent per cent growth inhibition at 500 ppm concentration tested in present investigation. Propiconazole was found next in order of inhibition. This results is in agreement with finding of Yadav *et al.* (2014) and Jain *et al.* (2014) they found good mycelia growth inhibition of *Fusarium spp.* by carbendazim. Difenoconazole and hexaconazole were performed well

against test fungus and gave 75.53 and 73.05 per cent mean growth inhibition respectively, in present investigation. This finding is also in consonance with the results of Bhat and Srivastava (2003), as they reported that triazole group of fungicides highly inhibitory to *F. solani*. The effectiveness of carbendazim towards *Fusarium spp.* has been also recorded by Soni andVerma (2010) and Taskeen *et al.* (2011).

Similarly, non systemic fungicides, mancozeb and Zineb proved to be the best and inhibited cent per cent mycelia growth at all concentrations(1000 to 2500 ppm). Chlorothalonil and copper oxychloride were found effective and gave 72.52 and 69.96 per cent mean growth inhibition of test pathogen, respectively (Table 2). These results are supported by finding of Singh *et al.* (2000) and Dar *et al.* (2013). They recorded that mancozeb proved to be the best for the growth inhibition of *F. solani and F. oxysporum*. Vadhera *et al.*(1997) also achieved effective control of *Fusarium solani* using zineb.

The results of combination of fungicides presented in Table 3 revealed that cymoxanil + mancozeb, carbendazim + mancozeb and tricyclazole + mancozeb were proved the most effective and gave cent per cent growth inhibition of test fungus at lowest concentration of 500 ppm. The effectiveness of carbendazim + mancozeb against *F. solani* has been reported by Chavan *et al.* (2009). Mancozeb was one of the compounds in three combinations which proved best in present finding. So in these combinations the efficacy may be due to mancozeb. In the previous results tricyclazole alone was ineffective; but the good inhibition recorded in the mixture of tricyclazole (TCZ) + mancozeb is due to mancozeb only. Carboxin + Thirum also gave 99.85 per cent inhibition of fungus at 2000 ppm concentration with mean inhibition of 98.79 per cent. Similar result was recorded by El Habbaa *et al.*(2002) working with *F. solani* causing root rot of ground nut. These results are in accordance with kapadiya *et al.* (2013) who reported that cymoxanil + mancozeb, carbendazim + mancozeb were most effective against *F.solani*.

The present results indicates that carbendazim, mancozeb, zineb and combination of fungicides *viz*; cymoxanil + mancozeb, carbendazim + mancozeb and Tricyclazole + Mencozeb were quite effective in controlling pathogen. The alternate application of these chemicals reduced the risk of development of resistant in pathogen. Such information will be helpful in formulation of schedule for management of disease.

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