International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
www.chemijournal.com
IJCS 2022; 10(4): 47-50

Received: 10-05-2022
Accepted: 15-07-2022

Surnar ST
Ph.D. Scholar, Department of Plant Pathology and Agril. Microbiology, PGI, MPKV, Rahuri, Maharashtra, India

Raghuwanshi KS
Rice Pathologist, Agricultural Research Station, Lonawala, MPKV, Rahuri, Maharashtra, India

Kubde AV
Ph.D. Scholar, Department of Plant Pathology and Agril. Microbiology, PGI, MPKV, Rahuri, Maharashtra, India

Anarse JB
PG Student, VNMKV, Parbhani, Maharashtra, India

Corresponding Author:
Surnar ST
Ph.D. Scholar, Department of Plant Pathology and Agril. Microbiology, PGI, MPKV, Rahuri, Maharashtra, India

In vitro bioefficacy of different fungicides against *Rhizoctonia bataticola* causing dry root rot disease in chickpea

Surnar ST, Raghuwanshi KS, Kubde AV and Anarse JB

Abstract
Dry root rot of chickpea caused by *Rhizoctonia bataticola* is an important disease affecting chickpea production. *In vitro* experiment was conducted to evaluate the efficacy of fungicides against dry root rot of chickpea. Different eleven fungicides were tested against *Rhizoctonia bataticola* in laboratory. Among the fungicides tested, carbendazim 50% WP, captan 50% WP, chlorothalonil 75% WP and tricyclazole 75% WP were found to be most effective with complete inhibition of mycelial growth of *Rhizoctonia bataticola* at all the concentrations tested which followed by propiconazole 25% EC (95.51%) and fosetyl-al 80% WP (89.63%) while bordeaux mixture 1% did not show any effect on the growth of test pathogen.

Keywords: fungicide, chickpea, dry root rot, *Rhizoctonia bataticola.*

Introduction

Chickpea is the most important pulse crop. Chickpea is a self-pollinating, diploid (2n = 16), annual crop belongs to the leguminousae family. Chickpea is one of the cheapest source of protein. India is the largest producer contributing to 70 per cent of world's chickpea production. Chickpea production in the year of 2019-2020 recorded 11.67 million tonnes with the productivity of 1142 kg/ha on 9.6 million ha area (FAOSTAT, 2019) [2]. In India Maharashtra state contributed in chickpea production with 2.2 million tonnes production, 1096 kg/ha productivity, grows on 2.04 million ha area (www.Indiastat.com). The number of chickpea importing countries increased from 64 in 1990 to 142 in 2009 suggesting increasing demand of the chickpea in the world. The yield of chickpea is low due to its susceptibility to various biotic and abiotic stresses. The crop is attacked by 172 pathogens consisting of fungi, bacteria and viruses from all over the world (Nene *et al*., 1996) [4]. Among all, the soil borne diseases, dry root rot caused by *Rhizoctonia bataticola*, wilt caused by *Fusarium oxysporum* f. sp. *ciceri* and collar rot caused by *Sclerotium rolfsii* which severely damage the chickpea under favorable conditions (Ravichandran *et al*., 2012) [6].

Among them Dry root rot caused by *Rhizoctonia bataticola* is emerging as the most destructive constraint to chickpea production, as the disease is more prevalent during hot temperature of 30 to 35°C and low soil moisture conditions (Taya *et al.*, 1988) [7]. *Rhizoctonia bataticola* is a soil and seed-borne necrotrophic fungal pathogen that has a global distribution (Dhingra and Sinclair, 1978) [1]. The most severe disease particularly in the Central and Southern zone, where the crop is mostly grown under rainfed. Therefore in the present study fungicides were evaluated in laboratory to know their efficacy against *Rhizoctonia bataticola*.

2. Materials and Methods

2.1. Isolation and purification of pathogen

Wilt infected chickpea plants showing typical wilt symptoms were collected from major chickpea growing districts of Western Maharashtra and brought to the laboratory. The tissue isolation method was followed to isolate the pathogen. Infected plants parts were washed in running tap water to remove soil adhered to the infected parts. The roots of wilted plants of chickpea were cut in to suitable small pieces and disinfected with 0.1 per cent mercury chloride solution for one to two minutes followed by three washings of sterilized water. Then each bit was dried on blotter paper and three bits were placed aseptically on previously sterilized PDA Petri plates and incubated these plates at 27±2 ^{0}C. When the growth of fungus was noticed, they were transfer to PDA slants to obtained pure cultures by purification.

In vitro evaluation of fungicides

Eleven fungicides with three concentration *viz*., 500, 1000 and 2000 ppm were evaluated against dry root rot pathogen under laboratory conditions by food poison technique (Nene and Thapliyal, 1993) [3]. The fungicide suspension was made by adding required quantity of fungicides to the melted PDA medium to obtain the desired concentration. 20 ml of poisoned medium was poured in each sterilized Petri plates. Mycelial disc of a 5 mm size from actively growing zone of seven days old culture was cut by a sterile cork borer and one such disc was placed at the centre of each plate. Control treatment was maintained without adding any fungicide to the medium. Three replications were maintained for each concentration. Then such plates were incubated at room temperature and radial growth was measured when fungus attained the maximum growth in control plates. Per cent inhibition of mycelial growth over control was calculated by using the formula given by Vincent (1947) [8].

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

Whereas,
I = Percent inhibition
C = Radial growth of test fungus in control plate
T = Radial growth of test fungus in treated plate

Table 1: Details of fungicides used in the experiment

Sr. No.	Common name	Chemical name	Trade name
1	Carbendazim 50% WP	Methyl-, 2 benzimidazole carbamate	Bavistin
2	Propiconazole 25% EC	1-[2-(2,4-Dichlorophenyl)-4-propyl-1, 3-dioxolan-2ylmethyl}-1H-1,2,4-traizole	Tilt
3	Hexaconazole 5% EC	(RS)-2-(2, 4-Dichlorophenyl)-1- (1H-1, 2, 4-triazole-1-yl)hexan-2-ol	Contaf
4	Difenconazole 25% EC	Difenoconazole 119446-68-3 Difenoconazole 1-((2-(2-Chloro-4-(4-chlorophenoxy)phenyl)-4-methyl-1,3-dioxolan-2-yl)methyl)-1H-1,2,4-triazole	Score
5	Copper Oxy Chloride 50%WP	dicopper chloride trioxide	Blitox
6	Fosetyl AL 80%WP	Aluminium tris(ethyl) phosphonate	Allite
7	Captan 50%WP	N-trichloromethyl-thio-4- cyclohefene-,1,2- dicarboximide	Captan
8	Bordeaux mixture 1%	5kg CuSo4 +5Kg Lime +500 litters water	
9	Chlorothalonil 75% WP	2,4,5,6-T Tetrachloro isophthalonitrile	Kavach
10	Metalaxyl 35% WS	methyl-(2-methoxyacetyl)-N-(2,6-xylyl)-DL-alaniate	Matrix
11	Tricyclazole 75% WP	5-methyl-1,2,4-triazolo[3,4-b][1,3]benzothiazole	SIVIC

Result and Discussion

In vitro evaluation of fungicides

The eleven fungicides were tested against *Rhizoctonia bataticola* at different three concentrations *viz*., 500, 1000 and 2000 ppm in the laboratory for testing bioefficacy against the test pathogen by using poisoned food technique. The results showing difference among the treatments and concentrations were found to be statistically significant are presented in Table 2, Plate 1 and Fig. 1.

Table 2: Efficacy of different fungicides against *Rhizoctonia bataticola* under *in vitro* conditions

Tr. No.	Treatment	Colony diameter at ppm (mm)*			Average colony diameter (mm)	% Inhibition at ppm			Average inhibition (%)
		500	1000	2000		500	1000	2000	
T_1	Propiconazole 25% EC	7.65	4.47	00.00	4.04	91.50 (73.05)	95.04 (77.14)	100 (90.00)	95.51 (77.77)
T_2	Hexaconazole 5% EC	31.44	17.00	12.66	20.36	65.06 (53.76)	81.11 (64.24)	85.93 (67.97)	77.36 (61.59)
T_3	Copper Oxychloride 50% WP	76.84	74.22	43.66	64.90	14.62 (22.48)	17.53 (24.75)	51.48 (45.85)	27.87 (31.86)
T_4	Chlorothalonil 75% WP	00.00	00.00	00.00	00.00	100 (90.00)	100 (90.00)	100 (90.00)	100 (90.00)
T_5	Difenconazole 25% EC	39.66	5.21	00.00	14.95	55.93 (48.40)	94.21 (76.07)	100 (90.00)	83.38 (65.95)
T_6	Metalaxyl 35% WS	52.50	34.06	25.85	37.47	41.66 (40.20)	62.15 (52.03)	71.27 (57.59)	58.36 (49.81)
T_7	Tricyclazole 75% WP	00.00	00.00	00.00	00.00	100 (90.00)	100 (90.00)	100 (90.00)	100 (90.00)
T_8	Fosetyl AL 80% WP	28.03	00.00	00.00	28.03	68.86 (56.08)	100 (90.00)	100 (90.00)	89.62 (71.21)
T_9	Carbendazim 50% WP	00.00	00.00	00.00	00.00	100 (90.00)	100 (90.00)	100 (90.00)	100 (90.00)
T_{10}	Captan 50% WP	00.00	00.00	00.00	00.00	100 (90.00)	100 (90.00)	100 (90.00)	100 (90.00)
T_{11}	Bordeaux mixture 1%	90	90	90	90	00.00	00.00	00.00	00.00
T_{12}	Control	90	90	90	90	00	00	00	00
	S. Em (±)	0.03	0.05	0.08	0.09	0.08	0.08	0.07	0.05
	CD at 5%	0.10	0.16	0.11	0.27	0.24	0.23	0.21	0.16

* : Average of three replications, Figures in parentheses are arc sin transformed values

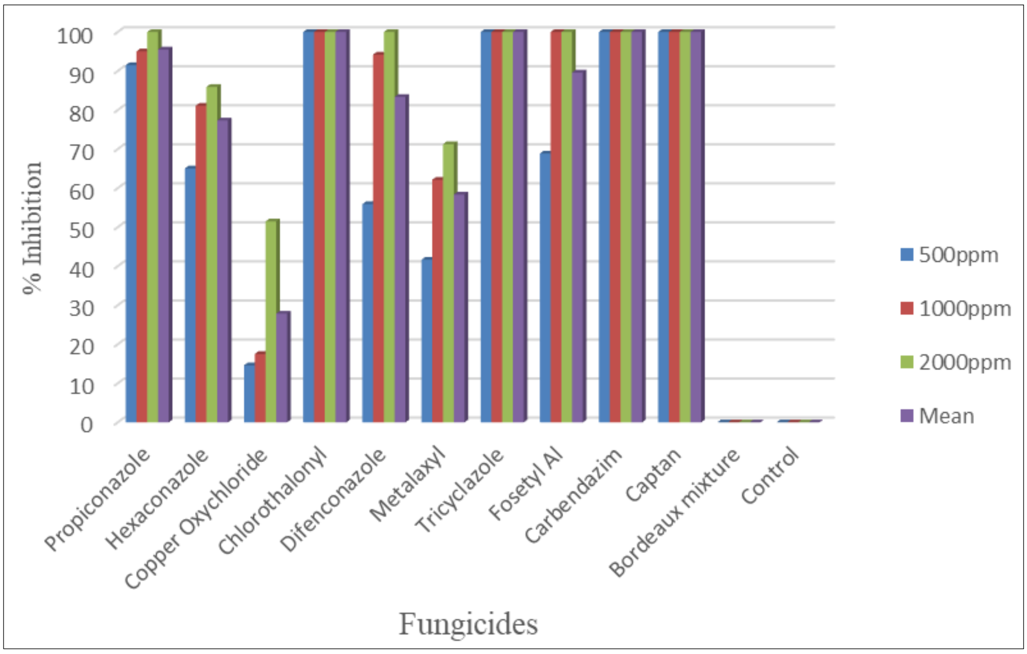

Fig 1: Efficacy of different fungicides against *Rhizoctonia bataticola* under *in vitro* conditions

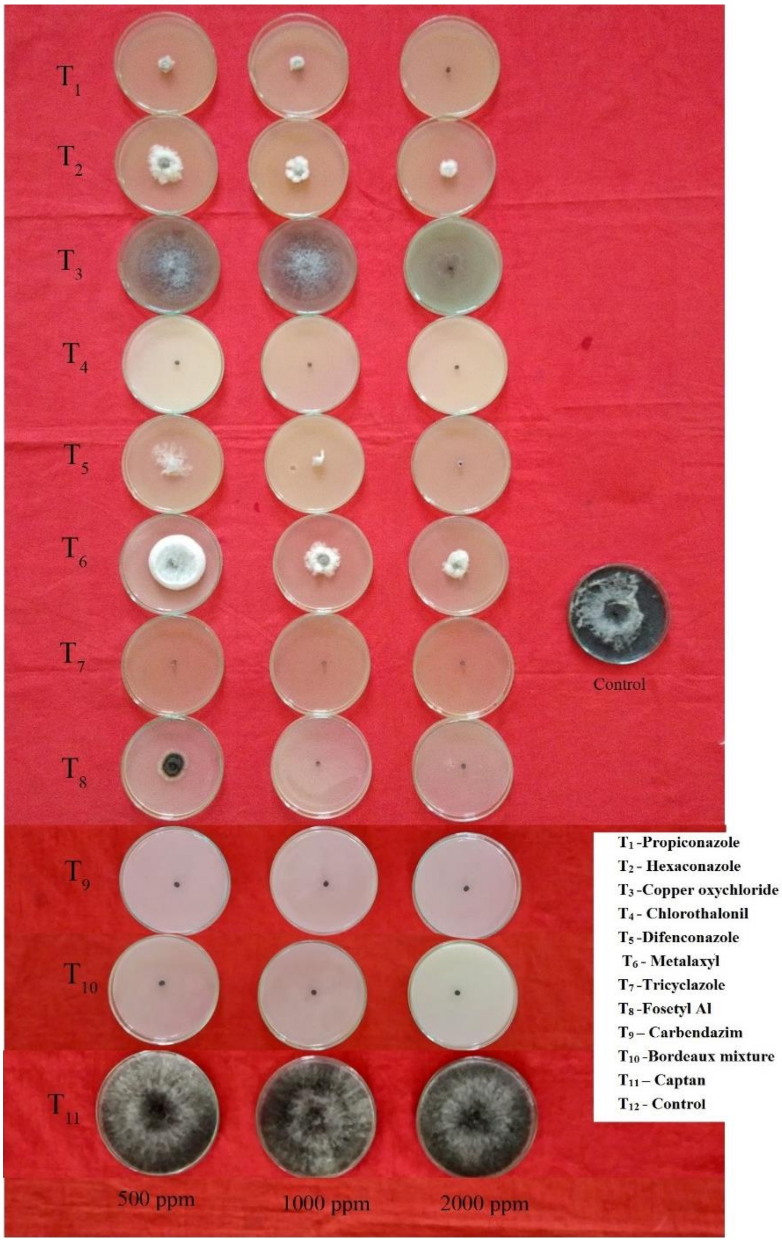

Plate 1: Efficacy of different fungicides on the growth inhibition of *Rhizoctonia bataticola* under *in vitro* condition

Mycelial growth

The data depicted in Table 2, Plate 1 and Fig. 1 presented that all the eleven fungicides tested exhibited a wide range of radial mycelial growth of *Rhizoctonia bataticola* and it was decreased drastically with increase in their concentrations. The fungicides resulted with mycelial growth in the range of 0.00 to 90.00 mm, 0.00 to 90.00 mm and 0.00 to 90.00 mm in 500, 1000 and 2000 ppm respectively, as against 90.00 mm in untreated control.

Among the fungicides, tricyclazole 75% WP, captan 50% WP, chlorothalonil 75% WP and carbendazim 50% WP resulted with no mycelial growth at 500, 1000 and 2000 ppm followed by fungicides with significantly least mycelial growth were propiconazole 25% EC (7.65, 4.47 and 0.00 mm, respectively), fosetyl al 80% WP (28.07, 0.00 and 0.00 mm), hexaconazole 5% EC (31.44, 17.00 and 12.66 mm, respectively), difenconazole 25% EC (39.66, 5.21 and 0.00 mm, respectively), metalaxyl 35% WS (52.50, 34.06 and 25.85 mm), copper oxychloride 50% WP (76.84, 74.22 and 43.66 mm) whereas maximum growth was recorded in bordeaux mixture 1% (90.00, 90.00 and 90.00 mm), respectively @ 500, 1000 and 2000 ppm.

Mycelial growth inhibition as per concentration of fungicide

The data depicted in Table 2, Plate 1 and Fig.1 presented that all of the fungicides tested at 500, 1000 and 2000 ppm significantly inhibited mycelial growth of *Rhizoctonia bataticola*, over untreated control and it was found to be increased with increase in concentrations of the fungicides. The mycelial growth inhibition resulted with the test fungicides ranged from 0.00 to 100 per cent in respective of concentrations over untreated control.

At 500 ppm concentration, fungicides, tricyclazole 75% WP, captan 50% WP, chlorothalonil 75% WP and carbendazim 50% WP inhibited cent percent mycelium growth of test pathogen. Next best fungicide was propiconazole 25% EC (91.54%) followed by, fosetyl al 80% WP (68.86%), hexaconazole 5% EC (65.06%), difenconazole 25% EC (55.93%), metalaxyl 35% WS (41.66%), copper oxychloride 50% WP (14.62%) whereas least growth inhibition recorded by bordeaux mixture 1% (0.00%).

At 1000 ppm concentration, fungicides, tricyclazole 75% WP, captan 50% WP, chlorothalonil 75% WP, fosetyl al 80% WP and carbendazim 50% WP inhibited cent percent mycelium growth of test pathogen. Next best fungicide was propiconazole 25% EC (95.04%) followed by difenconazole 25% EC (94.21%), hexaconazole 5% EC (81.11%), metalaxyl 35% WS (62.15%), copper oxychloride 50% WP (17.53%) whereas least growth inhibition recorded by bordeaux mixture 1% (0.00%).

At 2000 ppm concentration, fungicides, tricyclazole 75% WP, captan 50% WP, chlorothalonil 75% WP, fosetyl al 80% WP, propiconazole 25% EC, difenconazole 25% EC and carbendazim 50% WP inhibited cent percent mycelium growth of test pathogen. Next best fungicide was followed by hexaconazole 5% EC (85.93%), metalaxyl 35% WS (71.27%), copper oxychloride 50% WP (51.48%) whereas least growth inhibition recorded by Bordeaux mixture 1% (0.00%).

The similar results were found by Raj Kumar (2018) [5] who tested the efficacy of ten fungicides and found that at all the concentrations of carbendazim, hexaconazole and propiconazole were found to be highly effective in completely (100%) inhibiting the growth of the fungus. Veena *et al.* (2014) [9] reported that the fungicides copper oxychloride, captan, hexaconazole and tebuconazole were found to be highly effective in inhibiting mycelial growth of *R. bataticola* at all the concentrations tested. Ravichandran and Hegde (2012) [6] who found that carbendazim and difenoconazole were best with 100 per cent inhibition of mycelial growth of *R. bataticola.*

Conclusion

Among the eleven fungicides tested at different concentrations, carbendazim 50% WP, captan 50% WP, chlorothalonil 75% WP and tricyclazole 75% WP were completely inhibited (100%) the growth of the test pathogen at all three concentrations. Next best fungicide was propiconazole 25% EC (95.51%).

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