International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
www.chemijournal.com
IJCS 2022; 10(2): 30-33

Received: 17-01-2022
Accepted: 19-02-2022

Surnar ST
Ph.D. Scholar MPKV, Rahuri, Maharashtra, India

Raghuwanshi KS
Rice Pathologist, Agri. Research Station, Lonawala, Maharashtra, India

Kubde AV
Ph.D. Scholar, MPKV, Rahuri, Maharashtra, India

Anarase JB
M. Sc. VNMKV, Parbhani, Maharashtra, India

Corresponding Author:
Surnar ST
Ph.D. Scholar MPKV, Rahuri, Maharashtra, India

Efficacy of different fungicides against chickpea wilt (*Fusarium oxysporum* f. sp. *ciceri*)

Surnar ST, Raghuwanshi KS, Kubde AV and Anarase JB

Abstract
Chickpea wilt caused by *Fusarium oxysporum* f. sp. *ciceri* is the most destructive and widespread fungal disease of chickpea. It causes 100 per cent loss under favorable conditions. Nowadays chickpea wilt observed moderate to severe form in major chickpea growing areas in Western Maharashtra. This experiment was conducted to find out effective fungicides for the management of chickpea wilt. Different eleven fungicides were tested *in vitro* against *Fusarium oxysporum* f. sp. *ciceri* in laboratory. Among these fungicides tested carbendazim and tricyclazole were found to be highly effective in completely (100%) inhibiting the growth of the fungus and least growth inhibition was recorded in Bordeaux mixture (41.16%).

Keywords: Fungicide, chickpea, wilt, *Fusarium oxysporum* f. sp. *ciceri*

1. Introduction
Chickpea is the most important pulse crop. Chickpea is a self-pollinating, diploid (2n = 16), annual crop belongs to the leguminousae family. It is also known as Bengal gram. Chickpea is one of the cheapest source of protein. The yield of chickpea is low due to its susceptibility to various biotic and abiotic stresses. Chickpea wilt caused by *Fusarium oxysporum* f. sp. *ciceri* (Padwick) Matuo & K. Sato, is the most important soil-borne disease of chickpea throughout the global and particularly in the Indian subcontinent, the Mediterranean and California (Nene and Reddy, 1987) [8]. Attacks of the *Fusarium* wilt pathogen causes significant annual yield losses by destroying the crop completely (Halila & Strange, 1996) [4]. In India chickpea yield losses upto 10-15% annually (Jalali and Chand 1992), but it can cause 100% loss under favourable conditions (Halila and Strange, 1996) [4]. Chickpea wilt disease pathogen is seed borne (Pande *et. al.*, 2007) as well as soil borne. It can survive in soil for more than six months in the absence of its host and can cause severe damage to crop yield (Haware *et. al*., 1986) [6]. The pathogen can infect at all stages of plant growth with more incidences in flowering and pod filling stage (Haware, 1990) [5]. Early wilting causes more loss than late wilting, but seeds from late wilted plants are lighter, rough and dull than those from healthy plants (Haware and Nene, 1980). In India annual yield loss due to *Fusarium* wilt were estimated at 10% (Singh and Dahiya, 1973) [16]. The pathogen is mainly soil borne thus seed treatment by fungicides is consider the easiest and most economical way for management of the disease. Therefore present study was carried out to evaluate fungicides against *Fusarium* wilt of chickpea in laboratory.

2. Materials and Methods
2.1 Isolation and purification of pathogen
Chickpea plants, wilt infected and showing typical wilt symptoms were collected from major chickpea growing districts of Western Maharashtra and brought to the laboratory. The fungus was isolated by the tissue isolation technique on potato dextrose agar (PDA) media and incubated at 27±2 ^{0}C. The pure culture thus obtained were identified as *Fusarium oxysporum* f. sp. *ciceris* on the basis of morphological and cultural characters as described by Sneh *et al.*, (1991). All the eighteen isolates were tested for their pathogenicity on chickpea cultivar JG-62 under glasshouse condition. Isolate which showed highest per cent disease incidence was used for evaluation of fungicides.

2.2 *In vitro* evaluation of fungicides
Eleven fungicides with three concentration *viz*., 500, 1000 and 2000 ppm were evaluated against chickpea wilt pathogen under laboratory condition by food poison technique (Nene and Thapliyal, 1993) [9]. The details of the fungicides used are given table 1.

The fungicides suspension was made by adding required quantity of fungicides to the melted PDA medium to obtain the desire concentration. Twenty ml of poisoned medium was poured in each sterilized Petri plates. Suitable checks were maintained without addition of fungicides for comparison. After solidification of media five mm mycelium disc of ten days old test fungus was inoculated at the centre of petri plates and incubate at 28±2 °C for seven days.

Table 1: Details of fungicides used in the experiment

Sr. No.	Common name	Chemical name	Trade name
1	Carbendazim 50% WP	Methyl-, 2 benzimidzole 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 Difenoconazol 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

The diameter of the colony was measured in two directions and the average was recorded after seven days of incubation. Three replications were maintained for each treatment and experiment was designed in Complete Randomized Design (CRD). Percent inhibition of the fungus was calculated by using the following formula (Vincent, 1947) [20]:

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

Where

PI= Percent inhibition.

C= Radial growth of test fungus in control plate

T= Radial growth of test fungus in treated plate

3. Result and Discussion

3.1 *In vitro* evaluation of fungicides

The eleven fungicides were tested against *Fusarium oxysporum* f. sp. *ciceri* 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 and Plate 1.

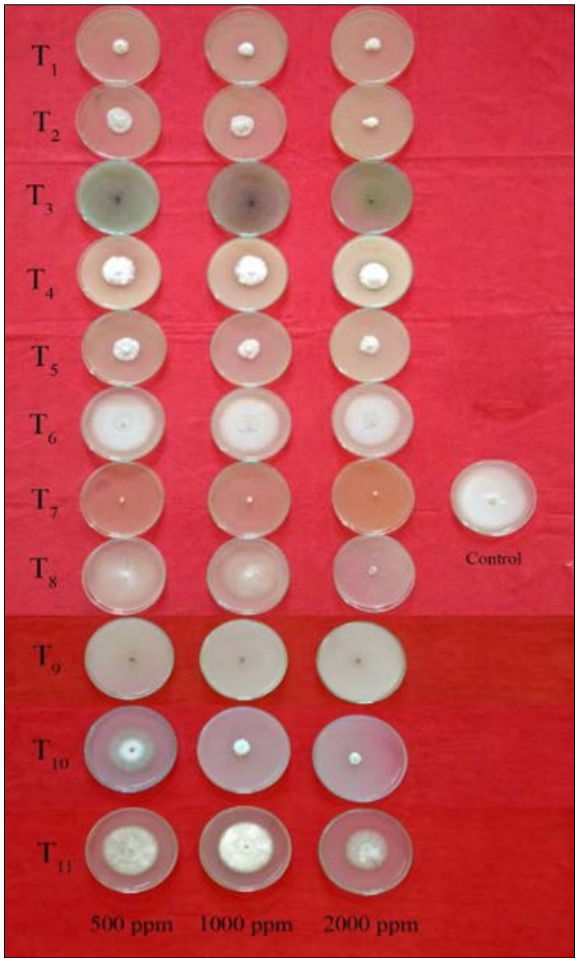

Plate 1: Efficacy of different fungicides on the growth inhibition of *Fusarium oxysporum* f. sp. *cicero* under *in vitro* condition

Mycelial growth

The data presented in Table revealed that all of the eleven fungicides tested exhibited a wide range of radial mycelial growth of *F. oxysporum* and it was decreased drastically with increase in their concentrations. The fungicides resulted with mycelial growth in the range of 0.00 to 80.01 mm, 0.00 to 71.75 mm and 0.00 to 55.73 mm @ 500, 1000 and 2000 ppm respectively, as against 90.00 mm in untreated control.

Among the fungicides, tricyclazole 75% WP and carbendazim 50% WP resulted with none of the mycelial growth at 500, 1000 and 2000 ppm followed by fungicides with significantly least mycelial growth were propiconazole 25% EC (17.15, 15.70 and 14.16 mm, respectively), hexaconazole 5% EC (31.30, 26.51 and 16.85 mm, respectively), difenconazole 25% EC (31.27, 25.60 and 21.22 mm, respectively), captan 50% WP (48.49, 22.33 and 15.22 mm, respectively), chlorothalonil 75% WP (36.15, 34.05 and 29.20 mm, respectively), fosetyl Al 80% WP (69.07, 52.57 and 4.60 mm, respectively), bordeaux mixture 1% (61.90, 52.03 and 44.89 mm respectively), metalaxyl 35% WS (71.67, 63.42 and 55.73 mm) and copper oxychloride 50% WP (80.01, 71.75 and 51.10 mm) respectively @ 500, 1000 and 2000 ppm.

Average mycelial growth of the test pathogen ranged from 0.00 mm to 67.62 mm. The 0.00 mm mycelial growth recorded in Tricyclazole 75% WP and carbendazim 50% WP fungicides followed by propiconazole 25% EC (15.67 mm), hexaconazole 5% EC (24.88 mm), difenconazole 25% EC (26.03 mm), captan 50% WP (28.68 mm), chlorothalonil 75% WP (33.13 mm), fosetyl AL 80% WP (42.09 mm), bordeaux mixture 1% (52.93 mm), metalaxyl 35% WS (63.60 mm) and maximum growth was recorded in copper oxychloride 50% WP (67.62 mm).

Mycelial growth inhibition

The data depicted in Table 2 and Plate 1 presented that all of the fungicides tested (each @ 500, 1000 and 2000 ppm) significantly inhibited mycelial growth of *F. oxysporum*, over untreated control and it was found increased with increase in concentrations of the fungicides tested.

The mycelial growth inhibition resulted with the test fungicides ranged from 11.09 to 100 per cent at 500 ppm, 20.23 to 100 per cent at 1000 ppm and 38.07 to 100 per cent at 2000 ppm concentrations respectively over untreated control.

At 500 ppm concentration, fungicides tricyclazole 75% WP and carbendazim 50% WP significantly inhibited mycelium growth of test pathogen (100%) and noted to be at par with each other. Next best fungicide was propiconazole 25% EC (80.94%) followed by, difenconazole 25% EC (65.25%), hexaconazole 5% EC (65.20%), chlorothalonil 75% WP (59.83%), captan 50% WP (46.12%), bordeaux mixture 1% (31.22%), fosetyl Al 80% WP (23.25), metalaxyl 35% WS (20.38%) whereas least growth inhibition recorded by copper oxychloride 50% WP (11.09%).

At 1000 ppm concentration, fungicides, tricyclazole 75% WP and carbendazim 50% WP significantly inhibited mycelium growth of test pathogen (100%) and noted to be at par with each other. Next best fungicide was propiconazole 25% EC (82.56%) followed by, captan 50% WP (75.18%), difenconazole 25% EC (71.51%), hexaconazole 5% EC (70.50%), chlorothalonil 75% WP (62.15%), bordeaux mixture 1% (42.18%), fosetyl Al 80% WP (41.58%), metalaxyl 35% WS (29.52%) whereas least growth inhibition recorded by copper oxychloride 50% WP (20.27%).

At 2000 ppm concentration fungicides, tricyclazole 75% WP and carbendazim 50% WP significantly inhibited mycelium growth of test pathogen (100%) and noted to be at par with each other. Next best fungicide was Fosetyl Al 80% WP (94.88%) followed by propiconazole 25% EC (84.26%), captan 50% WP (83.08%), hexaconazole 5% EC (81.26%), difenconazole 25% EC (76.42%), chlorothalonil 75% WP (67.55%), bordeaux mixture 1% (50.10%), copper oxychloride 50% WP (43.22%) whereas least growth inhibition recorded by metalaxyl 35% WS (38.07%).

Average mycelial growth inhibition recorded with the test fungicides ranged from 24.86 to 100.00 per cent. Among the tested fungicides, tricyclazole 75% WP and carbendazim 50% WP significantly inhibited mycelium growth of test pathogen (100%) and noted to be at par with each other. Next best fungicide was propiconazole 25% EC (84.58%) followed by hexaconazole 5% EC (72.32%), difenconazole 25% EC (71.07%), captan 50% WP (68.12%), chlorothalonil 75% WP (63.17%), fosetyl Al 80% WP (53.23%), bordeaux mixture 1% (41.16%), metalaxyl 35% WS (29.32%) whereas least growth inhibition recorded by copper oxychloride 50% WP (24.26%).

This results shows similarity with Patra and Biswas (2016) reported that carbendazim was highly effective in mycelial growth inhibition at 1000 and 1500 ppm concentrations and copper oxychloride least effective against *Fusarium oxysporum* f. sp. *ciceri.* Copper oxychloride was found least effective against *Fusarium oxysporum* f. sp. *ciceri* in present investigation. Dubey *et al.*, (2015) [2] reported that the fungicide Bavistin (carbendazim) inhibited 100% mycelium growth of *Fusarium oxysporum* f. sp. *ciceri.* Mahmood *et al.*, (2015) [7] also found that the carbendazim was highly effective in mycelial growth inhibition. Theradimani *et al.*, (2019) [19] reported carbendazim showed the highest (83.59%) inhibition of mycelium growth of the *Fusarium solani* of tomato followed by propiconazole (80.35%).

Table 2: Efficacy of different fungicides on the growth inhibition of *Fusarium oxysporum* f. sp. *ciceri* under *in vitro* condition

Sr. No.	Treatment	Colony diameter at ppm (mm)			Average	% Inhibition at ppm			Average inhibition%
		500	1000	2000		500	1000	2000	
T1	Propiconazole 25% EC	17.15	15.7	14.16	15.67	80.94 (64.11)	82.56 (65.31)	84.26 (66.63)	82.58 (65.38)
T2	Hexaconazole 5% EC	31.3	26.51	16.85	24.88	65.20 (53.85)	70.50 (57.10)	81.26 (64.35)	72.32 (58.40)
T3	Copper Oxychloride 50%WP	80.01	71.75	51.1	67.62	11.09 (19.45)	20.27 (26.76)	43.22 (41.11)	24.86 (29.86)
T4	Chlorothalonyl 75%WP	36.15	34.05	29.2	33.13	59.83 (50.67)	62.15 (52.03)	67.55 (55.27)	63.17 (52.58)
T5	Difenconazole 25% EC	31.27	25.60	21.22	26.03	65.25 (53.88)	71.51 (57.74)	76.42 (60.95)	71.07 (57.32)
T6	Metalaxyl 35%WS	71.67	63.42	55.73	63.60	20.38 (26.83)	29.52 (32.91)	38.07 (38.10)	29.32 (32.80)
T7	Tricyclazole 75%WP	00.00	00.00	00.00	00.00	100 (90.00)	100 (90.00)	100 (90.00)	100 (90.00)
T8	Fosetyl Al 80%WP	69.07	52.57	4.6	42.09	23.25 (28.83)	41.58 (40.15)	94.88 (76.93)	53.23 (46.77)
T9	Carbendazim 50%Wp	00.00	00.00	00.00	00.00	100 (90.00)	100 (90.00)	100 (90.00)	100 (90.00)
T10	Captan 50%WP	48.49	22.33	15.22	28.68	46.12 (42.78)	75.18 (60.12)	83.08 (65.71)	68.12 (55.58)
T11	Bordeaux mixture 1%	61.90	52.03	44.89	52.93	31.22 (33.97)	42.18 (40.50)	50.10 (45.06)	41.16 (39.88)

T12	Control	90	90	90	90	00.00	00.00	00.00	00.00
	S.Em ±	0.04	0.05	0.03	0.07	0.06	0.05	0.04	0.05
	CDat5%	0.11	0.14	0.10	0.20	0.19	0.15	0.12	0.14

4. Conclusion

In the present study, *In-vitro* testing of fungicides by food poison technique revealed that all the fungicides showed effectiveness in decreasing the fungal growth at increased concentration of the fungicides. The fungal growth was totally inhibited at 500, 1000 and 2000 ppm concentration of Carbendazim 50%WP and Tricyclazole 75%WP. Whereas Fosetyl AL80%WP and Propiconazole 25%EC inhibited mycelia growth 94.88% and 84.26% respectively at only 2000 ppm.

5. References

1. Andrabi M, Vaid A, Razdan VK. Evaluation of different measures to control wilt causing pathogens in chickpea. J Pl. Prote. Res. 2010;51(1):51-59.
2. Dubey SC, Singh VP, Upadhyay BK, Singh B. Combined application of fungal and bacterial bio-agents, together with fungicide and *Mesorhizobium* for integrated management of *Fusarium* wilt of chickpea. Biocontrol. 2015;60:413-424.
3. Golakiya BB, Bhimani MD, Akbari LF. Efficacy of different fungicides for the management of chickpea wilt (*Fusarium oxysporum* f. sp. *ciceri*). Int. J Chem. Studies. 2018;6(2):199-205.
4. Halila MH, Strange RN. Identification of the causal agent of wilt of chickpea in Tunisia as *Fusarium oxysporum* f. sp. *ciceri* race 0. Phytopathol. Mediterr. 1996;35:67-74.
5. Haware MP. *Fusarium* wilt and other important diseases of chickpea in the Mediterranean area. *Options* Méditerraneennes Série A: Séminaires. 1990;9:63-166.
6. Haware MP, Nene YL, Mathur SB. Seed borne disease of chickpea. Technical Bulletin 1. Danish Government Institute of seed Technology for developing countries. Copenh. 1986;1:1-32.
7. Mahmood Y, Khan MA, Javed N, Arif MJ. Comparative efficacy of fungicides and biological control agents for the management of chickpea wilt caused by *Fusarium oxysporum* f. sp. *ciceri*. The J Ani. & Plant Sci. 2015;25(4):1063-1071.
8. Nene YL, Reddy MV. Chickpea disease and their control. In: Saxena M. C., Singh, K. B. The Chickpea Oxon, UK: CAB International, 1987, 233-270.
9. Nene YL, Thapliyal PN. Fungicides in plant disease control. 3rd edition Oxford and IBH Publishing Co., New Delhi, 1993, 531.
10. Patole SP, Dhore SB., Pradhan RS and Shankara K. *In vitro* Evaluation of *Trichoderma viride* and *Trichoderma harzianum* against *Fusarium* Wilt of Chickpea. Int. J Pure App. Biosci. 2017;5(5):460-464.
11. Patil VB, Gawade DB, Surywanshi AP, Zagade SN. Biological and fungicidal management of chickpea wilt caused by *Fusarium oxysporum* f. sp. *ciceri.* An int.Quar. J life Sci. 2015;10(2):685-690.
12. Prafull Kumar, Mane SS. Efficacy of Fungicides and Biocontrol Agents against *Fusarium oxysporum* f.sp. *ciceri*. Int. J Curr. Microbiol. App. Sci. 2017;6(3):1450-1455.
13. Prashanti SK, Kulkarni S, Sangam VS, Kulkarni MS. Chemical control of *Rhizoctonia bataticola* (Taub.) Butler, the causal agent of root rot of safflower. Plant Dis. Res. 2000;15(2):186-190.
14. Rahman SU, Dar WA, Ganie SA and Singh PK. Comparative efficacy of *Trichoderma viridae* and *Trichoderma herzianum* against *F. oxysporium* f. sp. *ciceri* causing wilt of chickpea. Afri. J Microbio. Res. 2013;7(50):5731-5736.
15. Saravanakumari K, Thiruvudainambi S, Ebenezar EG, Senthil N. Efficacy of some fungicides and oil cakes extracts against basal rot of onion caused by *Fusarium oxysporum.* Int. J of Farm Sci. 2019;9(1):93-96.
16. Singh KB, Dahiya BS. Breeding for wilt resistance in chickpea. In: Symposium on Wilt Problem and Breeding for Wilt Resistance in Bengal Gram. Indian Agriculture Research Institute, New Delhi, India, 1973, 13-14.
17. Sugha SK, Kapoor SK, Singh B.M. Management of chickpea wilt with fungicides. Phytopathol. 1995;48(1):27-31.
18. Suman Patra, Mohan Kumar Biswas. Efficacy of fungicides for the management of chickpea wilt disease caused by *Fusarium oxysporum* f.sp. *ciceri*. Int. J Adv. Res. 2016;4(10):1457-1461.
19. Theradimani M, Amutha C, Parthasarathy S. Efficacy of antagonists, oil cakes and fungicides against Fusarium wilt disease in brinjal. Madras Agric. J. 2019, 10. DOI: 29321/MAJ.
20. Vincent JM. Distortion of fungal hyphae in the presence of certain inhibitors. Nature. 1947;159:850.
21. Wavare SH, Gade RM, Shitole AV. Antifungal efficacy of floral extracts, biocontrol agents and fungicides against *Fusarium oxysporum* f. sp. *ciceri.* Ind. Phytopathol. 2017;70(2):191-199.
22. Yadav SL, Ahir RR, Rathor BS, Yadav SM. Efficacy of Different Fungicides and Organic Amendments against Basal Rot of Onion Caused by *Fusarium oxysporum in vitro*. Plant Pathol. J. 2014;13:56-58.