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Management of Fusarium wilt of tomato by bioagents, fungicides and varietal resistance

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ABSTRACT

Tomato wilt caused by *Fusarium oxysporum* f.sp. l*ycopersici* is most important and destructive disease of tomato in Maharashtra, which causes considerable losses in yield of tomato. Therefore, present studies were undertaken to test the efficacy of eight fungicides and six bioagents *in vitro* and ten varieties of tomato in green house against Fusarium wilt of tomato Among the eight fungicides, Mancozeb + Carbendazim (0.125 + 0.05 %) had completely checked the growth of pathogen which inhibited 100 per cent growth of *Fusarium oxysporum* f.sp. *lycopersici* followed by Thiram + Carbendazim (0.15 + 0.05 %), Carbendazim (0.1 %), Thiram (0.3 %), Carboxin (0.2 %), Captan (0.25 %), Propiconazole (0.2 %), Mancozeb (0.25 %) with 93.75, 92.50, 90.00, 87.50, 81.25, 67.50 and 62.50 per cent growth inhibition over control, respectively. *In vitro*, the antagonistic effect of four species of *Trichoderma* and two bacterial bioagents were tested against this pathogen. Among the four *Trichoderma* species tested, *Trichoderma viride* recorded highest growth inhibition (85.00 %) of *Fusarium oxysporum* f.sp. *lycopersici* followed by *T. harzianum, T. hamatum, T. koningii* with 72.50, 70.00, 61.12 per cent growth inhibition over control, respectively and among two bacterial bioagents, *Bacillus subtillis* was found more effective than *Pseudomonas fluorescens* with 79.2 and 62.5 per cent growth inhibition over control. Among the ten varieties tested against *Fusarium oxysporum* f.sp. *lycopersici* in greenhouse, Bhagyashree and Dhanashree were found moderately resistant to wilt of tomato having 25.00 and 30.00 per cent disease incidence followed by RII-T-2, M-1-3, M-2-2, 8-1-5,NBC, 6-1, M-1-2 and RII-T1 with 55, 60, 60, 70, 70, 75, 80 and 85 per cent disease incidence, respectively.

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INTRODUCTION

Tomato (*Lycopersicon esculentum* L.) is one of the most important vegetable crops of India and cultivated on an area of about 865 thousand ha. The area under this crop in Maharashtra was about 52 thousand ha (Anonymous, 2011). Tomato wilt caused by *Fusarium oxysporum* f.sp. *lycopersici* is most important and destructive fungal disease causing substantial quantitative and qualitative losses. Considering the seriousness of the disease, the present studies were undertaken *in vitro* to test the efficacy of eight different fungicides and six bioagents (fungal and bacterial) against *Fusarium oxysporum* f.sp. *lycopersici* and to screen the different varieties of tomato against Fusarium wilt of tomato

in green house.

MATERIAL AND METHODS

***In vitro* evaluation of fungicides against *Fusarium oxysporum* f.sp. *lycopersici* :**

In vitro studies were undertaken at Department of Plant Pathology, Post Graduate Institute, Mahatma Phule Krishi Vidyapeeth, Rahuri in Completely Randomized Design with three replications and nine treatments. Eight fungicides were tested against *Fusarium oxysporum* by using poisoned food technique. Medium without fungicide served as control. The plates were incubated at temperature 27 ± 1°C. The observations on colony diameter and sporulation were recorded when Petriplate in control treatment was fully covered with mycelial growth after 7 days of inoculation. The per cent inhibition of growth of test fungus was calculated by using the formula given by Vincent (1947).

***In vitro* evaluation of bioagents against *Fusarium oxysporum* f.sp. *lycopersici* :**

The antagonistic activity of two bacterial bioagents *i.e. Pseudomonas fluorescens* and *Bacillus subtillis* and four species of *Trichoderma viz., T. harzianum, T. viride, T. koningii, T. hamatum* were tested on PDA against *Fusarium oxysporum* f.sp. *lycopersici* by dual culture inoculation technique. Mycelial discs of 5 mm diameter were cut from the margin of 7 days old cultures of test pathogen and antagonistic agents, respectively and placed opposite to each other on PDA in Petriplates having diameter of 90 mm. The discs were placed 30 mm away from each other. The Petriplates inoculated with discs of *Fusarium oxysporum* f.sp. *lycopersici* alone served as control. The inoculated plates were incubated in inverted position at 27 ± 1°C in BOD for seven days. The radial growth of *Fusarium oxysporum* f.sp. *lycopersici* was measured to assess the antagonistic potential of *Trichoderma* spp. against pathogen. The per cent growth of test fungus was calculated by using formula given by Arora and Upadhay (1978). For bacterial antagonists, *Fusarium oxysporum* culture was placed at the centre of Petriplate and after 48 hours, streaks of bacterial isolates were made equidistantly at the periphery of agar plates. Then the inoculated Petriplates were incubated at 27 ± 1°C for seven days and the diameter of inhibition zones was measured by using formula given by Arora and Upadhay (1978).

Screening of tomato varieties against *Fusarium oxysporum* f.sp. *lycopersici* :

In glass house 10 varieties of tomato were tested against tomato wilt caused by *Fusarium oxysporum* f.sp. *lycopersici*. The seeds of ten varieties of tomato were sown in earthen pots containing wilt sick soil. Wilt sick soil of test organism was prepared separately as per the procedure. The seed of each variety were sown in pot *i.e.* 5 seeds for each pot. Initially germination count was taken after 7 days after sowing. The subsequent observations on the incidence of wilt were recorded at an interval of 10 days upto 55 days after sowing. The per cent mortality was calculated by using following disease rating scale. The observations were recorded as per disease reaction scale given by Iqbal *et al*. (2005).

Reaction / grade		Percentage
Immune	-	0%
Highly resistance	-	1-10%
Moderately resistant	-	11-30%
Moderately susceptible	-	31-50%
Susceptible	-	51-70%
Highly susceptible	-	71-100%

RESULTS AND DISCUSSION

The findings of the present study as well as relevant discussion have been presented under the following heads :

***In vitro* evaluation of fungicides against *Fusarium oxysporum* f.sp. *lycopersici* :**

The results presented in Table 1 showed 100 per cent inhibition of mycelial growth of *Fusarium oxysporum* f.sp. *lycopersici* in Mancozeb + Carbendazim (0.125 + 0.05 %) and no sporulation of pathogen was observed followed by Thiram + Carbendazim (0.15 + 0.05 %), Carbendazim (0.1 %), Thiram (0.3 %), Carboxin (0.2 %), Captan (0.25 %), Propiconazole (0.2 %) and Mancozeb (0.25 %) with 93.75, 92.50, 90.00, 87.50, 81.25, 67.50 and 62.50 per cent growth inhibition over control, respectively. The fungicides observed effective in inhibition of growth and sporulation of *Fusarium oxysporum* f.sp. *lycopersici* in present investigations were also reported by several research workers. Quadri *et al*. (1982) reported that difolatan (0.2 %), thiram (0.2 %), carbendazim (0.2 %) and mancozeb (0.2 %) were effective against *Fusarium oxysporum* f. sp. *lycopersici* causing wilt of tomato. Etenbarian (1992), Singh *et al*. (1993), Narnawar and Kalekar (1997) reported that carbendazim was effective against tomato wilt caused by *Fusarium oxysporum* f.sp. *lycopersici*. Poddar *et al*. (2004) reported that the use of systemic fungicides *viz.*, Carbendazim, Propiconazole, Thiophanate methyl and Tubeconazole was effective against *Fusarium oxysporum* in chickpea. Musmade *et al*. (2009) reported that *in vitro* Carbendazim (0.1 %) completely inhibited the growth of pathogen.

***In vitro* evaluation of bioagents against *Fusarium oxysporum* f.sp. *lycopersici* :**

The data presented in Table 2 reveal that, all the antagonists showed inhibitory effect on growth of the test fungus and were effective in reducing the growth of pathogen.

Among *Trichoderma* species, *Trichoderma viride* recorded highest growth inhibition (85%) of *Fusarium oxysporum* f.sp. *lycopersici* over control followed by *T. harzianum, T. hamatum, T. koningii* with 72.50, 70.00, 61.12 per cent growth inhibition over control, respectively. Among the two bacterial bioagents, *Bacillus subtilis* was more effective showing 79.2 per cent inhibition of test pathogen.

Similar antagonistic effect of bioagents against *Fusarium oxysporum* f.sp. *lycopersici* causing wilt in tomato has also been documented by several research workers. Narnavar and Kalekar (1997) reported that *Trichoderma viride* was most effective than other *Trichoderma* spp. against tomato wilt caused by *Fusarium oxysporum* f.sp. *lycopersici*. Sahi and Khalid (2007) reported that *Trichoderma viride* was effective *in vitro* against *Fusarium oxysporum* followed by *T. harzianum, T. aureoviride, T. koningii* and *T. pseudokoningii*

Table 1 : *In vitro* efficacy of different fungicides on the growth and sporulation of *Fusarium oxysporum* f.sp. *lycopersici*

Sr. No.	Fungicides	Concentration (%) used	Mean colony diameter (mm)* after 7 days of inoculation	Sporulation (n)	Per cent inhibition of growth
1.	Mancozeb + Carbendazim	0.125 + 0.0 5	0.00	-	100.00
2.	Thiram + Carbendazim	0.15 + 0.05	5.00	-	93.75
3.	Carbendazim	0.1	6.00	-	92.50
4.	Thiram	0.3	8.00	-	90.00
5.	Carboxin	0.2	10.00	-	87.50
6.	Captan	0.25	15.00	+	81.25
7.	Propiconazole	0.2	26.00	++	67.50
8.	Mancozeb	0.25	30.00	++	62.50
9.	Control	-	80.00	++++	-
	S.E. ±		0.76		
	C.D. (P = 0.01)		2.28		

- = No sporulation; + = Poor sporulation; ++ = Moderate sporulation;
+++ = Good sporulation; ++++ = Abundant sporulation; * = Average of three replications;

Table 2 : *In vitro* antagonistic effect of biocontrol agents against *Fusarium oxysporum* f.sp. *lycopersici*

Sr. No.	Biological agents	Mean colony diameter (mm)* after 7 days	Per cent inhibition
1.	*T. viride*	12.00	85.00
2.	*T. harzianum*	22.00	72.50
3.	*T. hamatum*	24.00	70.00
4.	*T. koningii*	31.00	61.12
5.	*Bacillus subtilis*	16.6	79.2
6.	*Pseudomonas fluorescens*	30.0	62.5
7.	Control	80.00	-
	S.E. ±	0.78	
	C.D. (P = 0.01)	2.38	

* = Average colony diameter

Table 3 : Varietal reaction of tomato against *Fusarium oxysporum* f.sp. *lycopersici*

Sr. No	Varieties	Per cent disease incidence	Reaction
1.	8-1-5	70.00	S
2.	RII T1	85.00	HS
3.	M-1-2	80.00	HS
4.	M-2-2	60.00	S
5.	RII T2	55.00	S
6.	NBC	70.00	S
7.	6-1	75.00	HS
8.	M-1-3	60.00	S
9.	Bhagyashree	25.00	MR
10.	Dhanashree	30.00	MR

resulting in 62, 36, 24, 18 and 6 per cent reduction in colony growth of the test fungus, respectively. Calvet *et al.* (1990); Monda (2002) and Osuinde *et al.* (2002) also reported the effectivness of *Trichoderma* spp. and bacterial bioagents against tomato wilt caused by *Fusarium oxysporum* f.sp. *lycopersici*. Fravel *et al*. (2003) reported biocontrol of *Fusarium oxysporum.*

Reaction of tomato varieties against *Fusarium oxysporum* f.sp. *lycopersici* :

The result presented in Table 3 reveal the per cent disease incidence of tomato wilt of various varieties *u*nder greenhouse condition. Among ten verieties tested, Bhagyashree and Dhanashree were moderately resistant to wilt of tomato having 25 and 30 per cent disease incidence followed by RII-T-2, M-1-3, M-2-2, 8-1-5,NBC, 6-1, M-1-2 and RII-T1 with 55, 60, 60, 70, 70, 75, 80 and 85 per cent disease incidence, respectively.

The reaction of different varieties against *Fusarium oxysporum* f.sp. *lycopersici* cauing wilt of tomato has also been documented by several research workers. Mishra and Mishra (1993) observed that tomato varieties T-27 and BT-62 were highly resistant to wilt caused by *Fusarium oxysporum* f.sp. *lycopersici* BT-2, BT-3, BT-12,BT-30 and BT-34 were resistant and BT-1, T-22 and T-35 were moderately resistant. Narnavar and Kalekar (1997) reported that Dhaneshree, Bhagyashree and Rajeshree were resistant to Fusarium wilt of tomato while Roma, Pusa-120,HS-101 were susceptible. Wang *et al.* (2002) and Santos *et al.* (1993) also tested different varieties of tomato against Fusarium wilt of tomato and reported that IPAS and Agnela showed resistant to race 1 and highly susceptible to race 2, whereas Florida, Santa Adelia and Rio Grande were highly resistant to both the races. Dabbas *et al.* (2012) and Rawat *et al.* (2012) also worked on the related topic on brinjal and chickpea, respectively.

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