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In vitro evaluation of different fungicides against *Fusarium oxysporum* f. sp. *lycopersici,* causing wilt in tomato (*Solanum lycopersicum* L.)

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ABSTRACT

The tomato (*Solanum lycopersicum* L.), is one of the most frequently grown food crops and fusarium wilt is the most significant disease of tomato, which affects every stage of the plant (seedling, blooming, and fruiting), and it reduces yield around 40%. The pathogen was resistant to many fungicides that had previously been employed. To determine the effectiveness of new fungicides on the market, the present investigation used the approach of poisoning food technology. The fungicides tested *in-vitro* for effectiveness against *Fusarium oxysporum* f. sp. *lycopersici* successfully reduced mycelial growth. The two new combi fungicides that were most effective against *F. oxysporum* f. sp. *lycopersici* were Carbendazim 12% + Mancozeb 63% WP and Tebuconazole 50% + Trifloxystrobin 25% WG at 200 ppm concentration.

Key words: *Carbendazim 12% + Mancozeb 63% WP, Fusarium oxysporum f. sp.* lycopersici, *Poison food technique, Tomato.*

Introduction

The tomato (*Solanum lycopersicum* L.), one of the world's most widely grown and consumed vegetable crops, is regarded as the second most significant vegetable crop after the potato (Saeed *et al.,* 2014). Tomatoes are used to make various dishes, including tomato juice, tomato sauce, soup, and fresh fruit and salad (Alam *et al.,* 2007; Bhowmik *et al.,* 2012). It is cultivated during the *Kharif* and *Rabi* seasons and requires a relatively chilly climate. It can be cultivated year-round on various soils with mild summer temperatures, although well-drained sandy loam soils with a neutral response. India produced 22337.29 MT of tomatoes annually in 2020–21 on an area of approximately 801 thousand ha, with a productivity of 27.8 MT/ha. Tomatoes have gained popularity recently due to their excellent nutritional content and habitat-specific adaptability. A number of circumstances cause low yield, but diseases are the most serious. This crop is prone to a number of bacterial, viral, nematode, and fungal diseases. Tomato wilt is the worst fungal disease, and it has significantly reduced the quality and quantity of crops. *Fusarium oxysporum* f. sp. *lycopersici* destroys roots and reduces production by

30 to 40%, with certain instances seeing losses of up to 90% (Nirmaladev *et al.,* 2016) and it is the most significant vascular disease affecting worldwide in field conditions. The disease is characterized by the lower leaves drooping, turning brown, withering, and dying (Akrami *et al.,* 2015). The aerial mycelia of *Fusarium oxysporum* f. sp. *lycopersici* are round and white at first, then turn to pale pink (Nizamani *et al.,* 2020). During the past few years, it has been observed that fusarium wilt is most prevalent in tomato-growing regions due to favourable environmental conditions and that its treatment is currently being done effectively with various fungicides. As improper chemical use poses significant hazards to human health, using fungicides at the right concentrations and intervals could help reduce their harmful effects (Ghazanfar *et al.,* 2016; Kirk *et al.,* 2005). This study's main goal was to assess the effectiveness of several fungicides at various concentrations against the tomato disease fusarium wilt in *in-vitro* condition.

Materials and Methods

The *in-vitro* research was done in an aseptic environment in laboratory of Department Plant Pathology, Faculty of Agricultural Sciences, Siksha 'O' Anusandhan (Deemed to be University), Bhubaneswar, Odisha, India.

In vitro study of new fungicides against *Fusarium oxysporum* f. sp. *lycopersici*

The effectiveness of novel fungicides in preventing the mycelial growth of *Fusarium oxysporum* f. sp. *lycopersici* (NCBI accession number: OR262991) was assessed using the poisoned food technique. Before the experiment, the pathogen was cultured on PDA media for nine days to get pure culture. The PDA medium was prepared and melted, and the fungicidal suspension was added to the melted medium to obtain the necessary concentrations (100 ppm, 150 ppm, and 200 ppm). Each sterilized Petri plate was filled with twenty millilitres of a poisoned medium. The appropriate check (control) was kept without the addition of fungicide. A 5 mm mycelial disc was taken from the colony's edge and placed in the centre of the poisoned plates, where it was cultured at 25 °C for nine days. Every 24 hours up to 8 days, the pathogen's radial development was monitored in millimetres. For each treatment, three replications were kept. The Vincent (1927) formula was used to determine the percentage of the fungus's mycelial growth that was inhibited (Table 1).

$$\text{\% Growth inhibition} = \frac{\text{Mycelium growth in control} - \text{Mycelium growth}}{\text{Mycelium growth in control}} \times 100$$

Results and Discussion

All seven of the contact and combo fungicides (Table 2) tested *in-vitro* (Each at 100, 150, and 200 ppm) were found to be fungistatic and significantly reduced the mycelial growth of *F. oxysporum* f. sp. *lycopersici* over the untreated control at all three test concentrations (Table 2, Fig. 1, 2 and 3).

At 100 ppm, mycelial growth inhibition of *F. oxysporum* f. sp. *lycopersici* ranged from 38.53% to

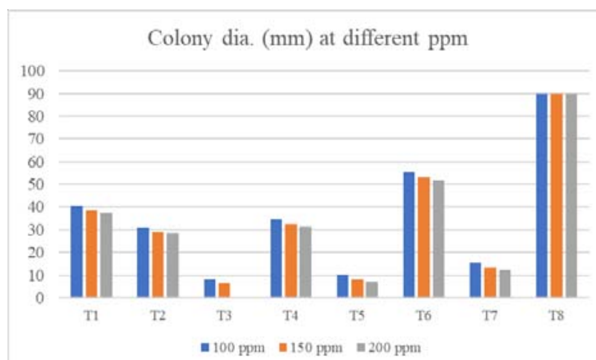

Fig. 1. Colony dia. (mm) at different ppm of *Fusarium oxysporum* f. sp. *lycopersici*.

Table 1. List of fungicide with trade name

Sl.No.	Name of fungicide	Trade name	Concentration
1.	Azoxystrobin 11% + Tebuconazole 18.3% SC	Spectrum	100, 150 and 200 ppm
2.	Carbendazim 50% WP	Bavistin	100, 150 and 200 ppm
3.	Carbendazim 12% + Mancozeb 63% WP	Saaf	100, 150 and 200 ppm
4.	Metalaxyl 4% + Mancozeb 64% WP	Ridomilgold	100, 150 and 200 ppm
5.	Tebuconazole 50% + Trifloxystrobin 25% WG	Nativo	100, 150 and 200 ppm
6.	Mancozeb 75 % WP	Indofil M45	100, 150 and 200 ppm
7.	Carboxin 37.5% + Thiram 37.5% DS	Vitavax power	100, 150 and 200 ppm

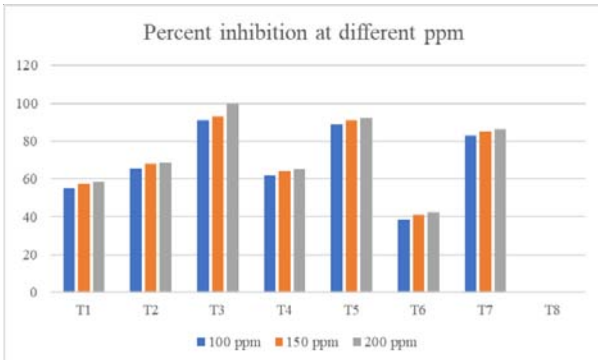

Fig. 2. Percent inhibition of *Fusarium oxysporum* f. sp. *lycopersici* at different ppm.

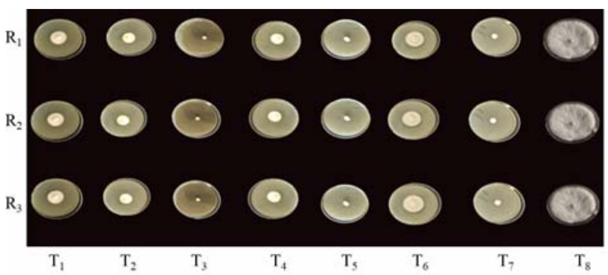

Fig. 3. *In vitro* study of new contact and combi fungicides against *Fusarium oxysporum* f. sp. *lycopersici* at 200 ppm.

90.99%. However, significantly highest and per cent mycelial growth inhibition (90.99%) was recorded with the fungicides viz., Carbendazim 12% + Mancozeb 63% WP, followed by Tebuconazole 50%+ Trifloxystrobin 25% WG (88.61%), Carboxin 37.5% + Thiram 37.5% DS (82.76%), Carbendazim 50% WP (65.66%), Metalaxyl 4% and Mancozeb 64% WP (61.77%), Azoxystrobin 11% and Tebuconazole 18.3% SC (55.16%). Inhibition of mycelial growth by the fungicide Mancozeb 75% WP was determined to be 38.58%, and found ineffective.

At 150 ppm, mycelial growth inhibition of *F. oxysporum* f. sp. *lycopersici* ranged from 40.99% to 93.07%. Highest per cent mycelial growth inhibition (93.07%) was recorded with the fungicides viz., Carbendazim 12% + Mancozeb 63% WP, followed by Tebuconazole 50%+ Trifloxystrobin 25% WG (91.02%), Carboxin 37.5% + Thiram 37.5% DS (85.17%), Carbendazim 50% WP (68.07%), Metalaxyl 4% and Mancozeb 64% WP (64.10%), Azoxystrobin 11% and Tebuconazole 18.3% SC (57.49%). Inhibition of mycelial growth by the fungicide Mancozeb 75% WP was shown to be (40.99%) ineffective.

Similar patterns in the pathogen's inhibition were seen at concentrations of 200 ppm, where the pathogen's mycelial growth inhibition ranged from 42.28 to 100.00 per cent. Highest per cent mycelial growth inhibition (100%) was recorded with the fungicides viz., Carbendazim 12% + Mancozeb 63% WP, followed by Tebuconazole 50%+ Trifloxystrobin 25% WG (92.10%), Carboxin 37.5% + Thiram 37.5% DS (86.46%), Carbendazim 50% WP (68.45%), Metalaxyl 4% and Mancozeb 64% WP (65.17%), Azoxystrobin 11% and Tebuconazole 18.3% SC (58.56%). Inhibition of mycelial growth by the fungicide Mancozeb 75% WP was shown to be (42.28%) ineffective.

From the above result, it showed that the combi fungicide Carbendazim 12% + Mancozeb 63% WP found effective against *F. oxysporum* f. sp. *lycopersici* followed by Tebuconazole 50%+ Trifloxystrobin 25% WG at 200 ppm concentration. The inhibition percent of both combi fungicide are very near to 150 ppm concentration. Similar works that proved Carbendazim 12% + Mancozeb 63% WP as most effective fungicide has earlier been done by Song *et al.* (2004), Harender Raj *et al.* (2005), Chhata and Jeewa

Table 2. *In vitro* study of new contact and combi fungicides against *Fusarium oxysporum* f. sp. *lycopersici*.

Tr. No.	Treatment	Colony dia. (mm) at ppm			% inhibition at ppm		
		100	150	200	100	150	200
T_1	Azoxystrobin 11% + Tebuconazole 18.3% SC	40.36	38.26	37.29	55.16	57.49	58.56
T_2	Carbendazim 50% WP	30.90	28.74	28.39	65.66	68.07	68.45
T_3	Carbendazim 12% + Mancozeb 63% WP	8.11	6.23	0.00	90.99	93.07	100.00
T_4	Metalaxyl 4% + Mancozeb 64% WP	34.41	32.31	31.34	61.77	64.10	65.17
T_5	Tebuconazole 50% + Trifloxystrobin 25% WG	10.24	8.08	7.11	88.61	91.02	92.10
T_6	Mancozeb 75 % WP	55.28	53.11	51.94	38.58	40.99	42.28
T_7	Carboxin 37.5% + Thiram 37.5% DS	15.51	13.35	12.18	82.76	85.17	86.46
T_8	Control	90.0	90.00	90.00	0.00	0.00	0.00
	C.D. (P= 0.05)	1.34	1.28	1.20			
	S. Em (±)	0.44	0.42	0.40			

Ram (2006), Raju *et al.* (2008), Singh (2009) and Srivastava *et al.* (2011).

Conclusion

According to the study's findings in *in-vitro*, Carbendazim 12% + Mancozeb 63% WP at 200 ppm is efficacious against *F. oxysporum* f. sp. *lycopersici*. Therefore, although more research is required, it is possible to advise tomato producers to use these fungicides to manage tomato wilt disease. Furthermore, the effective different contact and combi fungicide against fusarium wilt of tomato could be evaluated in the field.

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