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Research Article

Eco-friendly Management of Fungal Wilt of Tomato Caused by *Fusarium oxysporum* f. sp. *Lycopersici*

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ABSTRACT

The trial was conducted at Central Farm, Orissa University of Agriculture and Technology, Bhubaneswar in two consecutive years to study the efficacy of bio-agents in comparison with the fungicide, antibiotic and chemicals to manage wilt disease caused by *Fusarium oxysporum* f. sp. *lycopersici*. In the present study, two potent bio-agents *Trichoderma viride* (10^7 spore/ml) and *Pseudomonas fluorescens* (6×10^8cfu/ml) obtained from city market were also used for root dip of seedlings of tomato cv.BT-10 and soil treatment individually and also in combined form. The experimental results revealed that minimum wilt (2.89%) incidence and maximum yield (74.16 q/ha) was recorded from the treatment where seedling root dip with Carbendazim @ 0.15% and Streptocycline 0.015% + soil drench with Carbendazim (0.2%), Plantomycin (0.1%) and Blitox-50 (0.3%) was practised. It was followed by seedling root dip and soil treatment by only *P. fluorescens* which produced (70.35 q/ha) and was also better than other treatments in coastal plains of Odisha. Therefore, it is advisable to go for *P. fluorescens* as seedling dip and soil treatment against the Fusarium wilt in tomato in coastal plains of Odisha.

Keywords: *Seedling root dip; Soil treatment; Fusarial wilt; Tomato*

INTRODUCTION

Tomato (*Solanum lycopersicon* L.) is a major vegetable crop and the production was about 188 million tons in 2018 in the world. The major tomato growing countries are China, India, USA, Italy, Turkey and Egypt. In the year 2017 the production was 59,626,900 tons in China followed by India (20,708.000). China is the leading producer of tomatoes and produces 31% of world production followed by India and United states [1]. However, tomato is a popular vegetable crop in India and grown most of the states of India including Odisha [2]. In Odisha state, tomato is grown in winter season in all districts and in Kharif seasons in some pockets of the state. Odisha occupies 5th in position producing 1312.07(000) tons and shares 6.64% of total tomato production of the country in the year 2017-18 [2]. However, the productivity is low as compared to other states of India because of biotic and abiotic stresses. In biotic stress, diseases caused by fungi, bacteria, nematode and viruses play a major role in the reduction of productivity and yield of tomato per unit area. The crop is mostly affected by different diseases,*i.e.* damping off (species of *Pythium, Phytophthora, Fusarium, Phoma, Sclerotium*), septoria leaf spot (*Septoria lycopersicii)*, bacterial stem and fruit canker (*Clavibacter michiganensis* sub sp. m*ichiganensis)*, early blight (*Alternaria solani*), bacterial leaf spot (*Xanthomonas vesicatoria*), bacterial wilt (*Ralstonia solanacearum)*, leaf curl (tobacco leaf curl virus), mosaic (Tomato mosaic virus) and root knot disease *(Meloidogyne* spp.). Among them Fusarium wilt caused by *Fusarium oxysporum* f. sp. *lycopersici* is a major problem in cultivation of tomato crop in India [3,4] and also in the world. In India generally 30 to 40% yield losses was recorded due to this wilt disease and some time the loss may be gone upto 80% in favourable weather condition for the disease [5]. Various methods for control of Fusarium wilt disease in tomato was recommended by different workers using antibiotics and chemicals [6,7]. Now a days, biological control is gaining popularity day by day in lieu of chemical as the use of chemicals are toxic and hazardous to the environment [8,9]. Two promising bio-agents *i.e. Trichoderma viride* and *Pseudomonas fluorescens* were used country wide due to their high adaptability [10]. Moreover, some strains of *P. fluorescens* were also found compatible with some fungicides as reported by Manjunath et al. [11]. Shrawan et al. [12] reported the fungicides, like Bavistin (0.1%), Copper oxychloride (0.1%) and Mancozeb (0.1%) showed fungicidal activity against wilt pathogen *in vitro* conditions. Gholve et al. [13] also recorded the antifungal activity of Bavistin against *F. oxysporum* f. sp. *lycopersici* in laboratory conditions.

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Hence, a field trial was conducted at Central Farm, Orissa University of Agriculture and Technology, Bhubaneswar at coastal plains. to study the performance of bio-agents *T. viride* and *P. fluorescens* against fusarium wilt caused by *F. Oxysporum* f. sp. *lycopersici* in the cultivar BT-10 of tomato crop in two consecutive years, *i.e.* 2008-09 and 2009-10 under field conditions.

MATERIALS AND METHODS

Field trials were conducted at Central Farm, Orissa University of Agriculture & Technology Bhubaneswar, Odisha in Rabi season with six treatments and four replications during 2008-09 and 2009-10. In the plots the fertilizers (NPK) were added @ 120:75:100. The tomato cv. BT-10 crop was grown under irrigated condition with 60cm × 40 cm spacing and plot size was 5.5m × 4.0 m. Three kilograms of each bioagent [*T. viride* (10^7spore/ml) and *P. fluorescens* (6 × 108 cfu/ml)] was mixed separately with 10.00 quintal of rotten FYM uniformly and allowed it for 21 days for multiplication of bio agents under shade with adequate moisture. The treatments were used as follows, i.e. T1 = Seedling root dip with *Trichoderma viride* + Soil treatment with *T. viride*, T2 = Seedling root dip with *Pseudomonas fluorescens* + Soil treatment with *P. fluorescens*, T3 = Seedling root dip with *T. viride* and *P. fluorescens* + Soil treatment with *T. viride* and *P. fluorescens*, T4 = Seedling root dip with Carbendazim @ 0.15% and Streptocycline 0.015% + Soil drench with Carbendazim (0.2%),Plantomycin (0.1%) and Blitox-50 (0.3%), T5 = Soil application of Bleaching powder @ 15 kg /ha + Soil application of *T. viride* + 3 times drenching with *T. viride* + *P. fluorescens*, T6= Control.

The following procedures were practised in conducting the experiments. In seedling root dip method, 25 g of bioagent formulation obtained from city market containing of each type (10^7 spore/ml of *T. viride*, 6 × 10^8cfu/ ml of *P. fluorescens*) was mixed in 1lit of water as per instructions. 35 days old seedlings of tomato cv. BT-10 were dipped in bio formulation suspensions for 20 min before transplanting in the main field. Soil application of bio-agent and fungicides (Carbendazim @ 0.15%) as well antibiotics was applied at the time of hoeing and earthing up of the plant. The Bleaching powder (10% chlorine) was applied in furrow and mixed in the soil followed by light irrigation (after earthing up). The bio-agent was applied after application of chemical. In each treatment, Carbendazim 63% + Mancozeb12% was sprayed to control *Alternaria* blight @ 2g/lit. After establishments of seedlings in field, the transplanted plots were monitored every day. Wilted plants were uprooted carefully and microscopically examined and identified. Fungal wilting incidence was calculated as follows.

Wilt incidence (%) = (Number of plants wilted / Total number of plants) × 100

RESULTS AND DISCUSSION

Result revealed that minimum wilt incidence (2.89%) was recorded from the treatment where seedling root dip with Carbendazim @ 0.15% and Streptocycline (0.015%) + soil drench with Carbendazim (0.2%), Plantomycin (0.1%) and Blitox-50 (0.3%) followed by seedling root dip and soil treatment with *T. viride* (T1) and *P .fluorescens* (T2) with reduction of Fusarium wilt disease incidence over control ,i.e. 76.60, 55.14 and 51.09% respectively (Table 1). No significant variation in wilt disease incidence was recorded in pooled data of two years in the treatments T1, T2 and T3. It indicates that application of fungicide for control of wilt disease was found better than the application of microbial antagonist alone in the field. In contrast to our result, Singh et al. [6] reported that wilting inhibition capacity was found more in *P. fluorescens* than in *T. viride*; while in our case, *T. viride* was found more effective than the *P. fluorescens* in wilt disease reduction individually. Although the variation in fusarium wilt incidence in both the bio-agents was found insignificant. Table 2 reveals that maximum yield 79.16 q/ha was recorded in treatment T4 seedling root dip with Carbendazim (0.15%) and Streptocycline (0.015%) and soil drenching with Carbendazim (0.2%), Plantomycin (0.1%) and Blitox-50 (0.3%) followed by T2 [seedling root dip and soil treatment with *P. fluorescens* (70.41q/ha)] and T1 (seedling root dip and soil treatment with *T. viride*) with enhancement of crop yield 37.22,22.05 and 19.19% respectively. There was no significance difference in yield among treatments T1, T2 and T3. However, maximum wilt incidence (12.35%) was recorded in control with lowest yield 57.69q/ha. The effectiveness of *T. viride* and *P.*

Table 1: Effect of different treatments on Fusarial wilt incidence in tomato.

Treatments	Wilt incidence (%)		Pooled Data of wilt incidence (%)	Percent decrease in wilt incidence over control
	1st year	2nd year		
T1 = Seedling root dip with *T. viride* + soil treatment with *T. viride*	3.23 (9.84)*	7.86 (16.18)	5.54 (13.04)	55.14
T2 = Seedling root dip with *P. fluorescens* + soil treatment with *P. fluorescens*	2.78 (9.23)	9.29 (17.75)	6.04 (13.49)	51.09
T3 = Seedling root dip with *T. viride* and *P .fluorescens* + soil treatment with *T.viride*and, *P. fluorescens*	6.22 (14.24)	7.14 (15.13)	6.68 (14.64)	45.91
T4 = Seedling root dip with Carbendazim @ 0.15%and Streptocycline 0.015% + soil drench with Carbendazim (0.2%), Plantomycin (0.1%) and Blitox-50 (0.3%)	1.58 (6.73)	4.20 (11.72)	2.89 (9.23)	76.60
T5 = Soil application of Bleaching powder @ 15 kg/ha + Soil application of *T. viride* + 3 times drenching with *T. viride* + *P. fluorescens*	8.93 (16.43)	5.00 (12.74)	6.96 (14.54)	43.64
T6 = Control	10.07 (17.81)	14.64 (21.94)	12.35 (19.87)	
SE (m) ±	2.43	0.75	1.59	
CD (5%)	7.34	2.20	4.77	

*Figures in parentheses are in transformed angular values

Table 2: Effect of different treatments on yield of tomato in the year 2008-09 and 2009-10.

Treatments	Yield(q/ha) 1st year	Yield (q/ha) 2nd year	Pooled	Per cent increase in yieldover control
T1 = Seedling root dip with *T. viride* + soil treatment with *T. viride*	77.16	60.37	68.76	19.19
T2 = Seedling root dip with *P. fluorescens* + soil treatment with *P. fluorescens*	78.86	61.95	70.41	22.05
T3 = Seedling root dip with *T. viride* and *P. fluorescens* + soil treatment with *T. viride* and *P. fluorescens*	68.07	66.49	67.28	16.62
T4 = Seedling root dip with Carbendazim@0.15% and Streptocycline 0.015% + soil drench with Carbendazim (0.2%), Plantomycin (0.1%) and Blitox-50 (0.3%)	78.75	79.58	79.16	37.22
T5 = Soil application of Bleaching powder @ 15.o kg/ha + soil application of *T. viride* + 3 times drenching with *T. viride* + *P. fluorescens*	65.58	71.68	68.68	19.05
T6= Control	61.93	53.45	57.69	-
SE (m)±	1.63	1.27	1.45	
CD (5%)	4.95	3.56	4.26	

fluorescens have been studied earlier. The potentiality of *T. viride* present in fungal consortiumwas already established in vegetated western Himalayan Agro ecosystem in reducing wilt and increasing in yield of tomato [14]. The individual application of *P. fluorescens* was found better than *T. viride* with respect to yield. Fluorescent *Pseudomonadas* are a group of plant growth promoting rhizobacteria andis known to protect soil borne plant pathogenic organisms.This plant growth promoting activity (increase in shoot, root length as well as in volume) had already been reported [15]. The combined application of *T. viride* and *P. fluorescens* were less effective in suppressing the wilt than individual application of biocontrol agent. Biocontrol applied in combination with Bleaching powder @ 15.00 kg /ha as soil application also reduced wilt incidence significantly but variation was found in both the years. Biocontrol agent like *P. fluorescens* was also compatible with some fungicides as reported earlier by Manjunath et al. [11]. Shrawan et al. [12] reported that among different fungicides tested, Bavistin (0.1%) was fully supressed the growth of 20 isolates of *F. oxysporum* f. sp. *pisi in vitro* conditions collected from different places of Uttar Pradesh followed by Copper oxychloride (0.1%) and Mancozeb (0.1%).

CONCLUSION

From our findings, it is concluded that application of fungicides and antibiotic reduced Fusarium wilt incidence in tomato and increased the yield of the crop better among other treatments. Individual biocontrol agents like *T. viride* and *P. fluorescens* applied as root dip treatment and soil application could also reduce the wilt disease of tomato at field level and were found statistically at par with chemical treatment. Hence, the bio-agent *Trichoderma viride* and *Pseudomonas fluorescens* can be applied as seedling root dip and soil application for control of Fusarium wilt disease of tomato.

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