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Eco-Friendly and Integrated Approaches for Management of Early Blight Disease in Tomato

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A B S T R A C T

Field experiments were conducted for three consecutive seasons of Rabi 2010-11, 2011-12 and 2012-13 in the farmer's field of Jagatsinghpur district of Odisha in order to study the synergistic effect of cultural practice, seed priming and foliar spray with bioagents on management of Alternaria blight of tomato. The trial was laid out in Randomized Block Design comprising ten treatments and three replications with individual plot size of 8.1 m^2 (3.0 x 2.7m). The planting was made with a spacing of 60cm x 40cm with recommended dose of fertilizer such as 125:60:100 Kg N_2:P_2O_5:K_2O/ha. Removal of infected lower leaves, staking of tomato plants, seed priming with *Trichoderma viride* followed by foliar spraying with *Trichoderma viride* and *Pseudomonas fluoroscens* recorded the minimum PDI of 3.4%, 5.8% respectively reducing the early blight incidence by 93.4% and 88.8% respectively over control. Removal of infected lower leaves, staking of plants, seed priming and foliar spray of *Trichoderma viride* gave maximum fruit yield of 328.4q/ha followed by 324.9q/ha, when foliar spraying was done with *Pseudomonas fluorescens.* The foliar spray with *Trichoderma viride* and *Pseudomonas fluoroscens* with priming of seeds were also proved effective by reducing the disease by 78.0% and 73.0% as well as increasing the yield by 42.4% and 43.7% respectively. Considering the effects of cultural practices such as the removal of infected lower leaves and staking of plants could reduce the disease by 50.2% and thereby increasing the fruit yield over control about 26.5% which recorded 1: 9.7 cost benefit ratio and found to be the best in all respect.

Introduction

Tomato (*Lycopersicon esculentum* Mill.) belongs to family solanaceae and is the second most important vegetable crop next to potato. Tomato is highly sensitive to environmental stresses and remarkable losses in yield are caused by several diseases. About 200 diseases have been reported on tomato. Among these early blight (*Alternaria solani*), late blight (*Phytophthora infestans*), bacterial wilt and brown rot (*Ralstonia solanacearum*) and leaf curl complex are most common and serious diseases of tomato worldwide including India? However the early blight caused by *Alternaria solani* is a major

production constraint in tomato wherever the crop is grown. Early blight is wide spread throughout the tropics and temperate zones (Waals *et al.,* 2004). In India the disease occurs in all parts of the country which causes loss in fruit yield. The loss in yield due to early blight disease in tomato was 0.75 to 0.77 t/ha for every 1% increase in disease severity (Saha and Das, 2012). As high as 86 per cent yield loss has been reported (50-86%) in tomato (Mathur and Sekhawat, 1986). Every one percent increase in intensity can reduce yield by 1.36 per cent and complete crop failure can occur when the disease severity is high (Ngoc *et al.,* 2013). Among fungal diseases blight caused by Alternaria species was the most predominant with the crop loss in the field ranging from 70-100 per cent as reported from a survey and loss assessment in West Bengal India (Kanjilal *et al.,* 2000). Keeping in view the fungicidal hazards to nature and development of resistance of pathogenic fungi towards chemicals; the environmentally safe methods of crop protection are to be experimented. Application of *Trichoderma viridae* both to seed and soil may be used as an effective treatment to achieve disease reduction and develop ecofriendly strategy in tomato (Nirupama Devi *et al.,* 2013). Even detachment of diseased foliage may slower down the rate of disease spread and can be integrated with other cultural and biological management approaches. Several bioagents were also found antagonistic against fungal pathogens. Hence the present investigation based on an integration of biological and cultural methods of blight and fruit rot management in tomato.

Materials and Methods

In order to study the synergistic effect of cultural practice, seed priming with bioagent along with foliar spray with antagonistic fungi and bacteria on management of Alternaria blight of tomato, field trials were conducted for three consecutive seasons of Rabi 2010-11, 2011-12 and 2012-13 in the farmers' field at Tirtol of Jagatsinghpur district of Odisha with the test variety Utkal Kumari (BT-10).

The trail was laid out in Randomized Block Design with three replications. The various treatments included under study were as follows: T_1 = Removal of infected lower leaves, staking of plants, T_2 = Seed priming with Sanjeevani (6gm/kg), $T_3 = T_1 + T_2$, $T_4 = T_1$ + Spraying with *Trichoderma viride,* $T_5 = T_1$ + Spraying with *Pseudomonas fluorescens*, $T_6 = T_2$ + Spraying with T. viride, $T_7 = T_2$ + Spraying with *P. fluorescens,* $T_8 = T_3$ + Spraying with *T. viride,* $T_9 = T_3$ + Spraying with *P. fluorescens*, T_{10} = Control (untreated)

The seed treatment was done 24 hours before sowing. Sanjeevani is *Trichoderma viride* based biofungicide available commercially (International Panaacea Ltd., New Delhi) in solid formulation. For cultural management, staking of plants as well as removal of infected lower leaves was practiced after appearance of disease symptoms in the field. The crop was planted with a row to row spacing of 60cm and plant to plant spacing of 40cm, being adopted in a plot size of 8.1sq.mt. (3.0m x 2.7m). All the agronomic practices as generally recommended was followed with the fertilizer dose of N_2: P_2O_5: K_2O: : 125 : 60 : 100 kg/ha. First foliar spraying of bioagents was applied at the initiation of disease followed by 2nd spray at 10 days interval. The percent disease incidence (PDI) and percent disease control (PDC) were calculated (Wheeler, 1969). The observations were taken to find out the marketable as well as rotted fruit yield. Economics of ecofriendly management was worked out on the basis of prevailing market price of tomato fruits @ Rs. 800/- per quintal, labour was @ Rs. 200/- per day per person and cost of the bioagents.

Results and Discussion

The data presented in Table 1, 2 and 3 revealed that the removal of infected lower leaves, staking of plants, seed priming with Sanjeevani along with foliar spray of antagonistic fungus *Trichoderma viride* (T_8) and *Pseudomonas fluroscens* (T_9) recorded the lowest mean PDI of 3.4 and 5.8 respectively reducing the incidence of disease by 93.4 and 88.8 per cent respectively over control. The average incidence of early blight was recorded the highest PDI of 51.80 in untreated control and it is in close conformity with the range of blight incidence(23.44 to 70.94 per cent) as reported by Munde *et al.*, (2013).

The treatment T8 recorded significantly lower mean PDI and also maximum mean fruit yield of 328.4q/ha as compared to 218.1q/ha in control plot.

T_9 was found at par with T_8 and significantly higher than any other treatment which recorded 324.9q/ha of marketable fruits. The increase in marketable fruit over control was 50.6% in T8 followed by 49.0% in T_9.

Table.1 Effect of ecofriendly management on incidence of *Alternaria* blight and fruit rot in tomato

Treatments	Mean Percent Disease Incidence (PDI)			Mean	% disease reduction
T_1: Removal of infected lower leaves, staking of plants	26.4 (30.89	25.8 (30.49)	25.2 (30.10)	25.8 (30.49)	50.2
T_2: Seed priming with Sanjeevani	25.6 (30.37)	22.3 (28.15)	23.4 (28.84)	23.8 (29.12)	54.1
T_3:T_1 + T_2	18.1 (25.11)	19.4 (26.11)	20.0 (26.56)	19.2 (25.93)	62.9
T_4:T_1 + Spraying *Trichoderma viride*	15.1 (22.81)	16.3 (23.75)	15.8 (23.29)	15.7 (23.28)	69.7
T_5:T_1 + Spraying *Pseudomonas fluoroscens*	16.8 (24.06)	17.1 (24.38)	16.0 (23.56)	16.6 (24.00)	68.0
T_6:T_2 + Spraying *T. viride*	10.8 (19.07)	12.1 (20.33)	11.4 (19.69)	11.4 (19.70)	78.0
T_7:T_2 + Spraying *P. fluoroscens*	14.1 (21.93)	13.2 (21.20)	14.8 (22.51)	14.0 (21.88)	73.0
T_8 : T_3 + Spraying *T. viride*	2.5 (9.05)	3.6 (10.81)	4.1 (11.61)	3.4 (10.49)	93.4
T_9 :T_3 + Spraying *P. fluoroscens*	5.8 (12.46)	6.4 (14.43)	5.1 (12.99)	5.8 (13.29)	88.8
T_{10} : Control	48.2 (43.96)	54.5 (47.67)	52.8 (46.61)	51.8 (46.08)	-
SE (m)±	1.24	1.01	0.87	0.54	
CD (0.05)	3.68	3.01	2.58	1.62	
CV (%)	8.95	7.09	6.13	3.86	

Table.2 Effect of the integrated ecofriendly approach of blight management on Fruit yield of tomato

Treatments	Marketable fruit yield (Q/ha)			Mean	% yield increase over control	Rotted fruit yield (Q/ha)			Mean
	2010-11	2011-12	2012-13			2010-11	2011-12	2012-13	
T_1: Removal of infected lower leaves, staking of plants	275.6	278.3	274.1	276.0	26.5	30.1	31.6	28.3	30.0
T_2: Seed priming with Sanjeevani	278.6	280.3	282.4	280.4	28.6	32.4	31.3	33.6	32.4
T_3:T_1 + T_2	295.3	297.4	299.6	297.4	36.4	31.6	27.4	28.1	29.0
T_4:T_1 + Spraying *Trichodermaviride*	308.5	310.6	307.3	308.8	41.6	24.6	26.4	27.3	26.1
T_5:T_1 + Spraying *Pseudomonas fluoroscens*	303.6	304.8	302.1	303.5	39.2	27.3	29.2	29.9	28.8
T_6:T_2 + Spraying *T. viride*	310.8	308.4	312.6	310.6	42.4	20.3	22.4	25.6	22.8
T_7:T_2 + Spraying *P. fluoroscens*	315.4	311.2	313.6	313.4	43.7	22.2	24.8	22.8	23.3
T_8 : T_3 + Spraying *T. viride*	330.6	325.8	328.9	328.4	50.6	15.2	11.8	13.0	13.3
T_9 :T_3 + Spraying *P. fluoroscens*	325.3	323.4	326.1	324.9	49.0	17.1	18.2	18.8	18.0
T_{10} : Control	218.4	220.4	215.6	218.1	-	36.4	38.3	38.0	37.6
SE (m)±	4.11	2.59	3.16	1.21		2.33	2.75	2.21	0.96
CD (0.05)	12.20	7.70	9.38	3.61		6.93	8.17	6.57	2.85
CV (%)	2.41	1.51	1.85	0.71		15.72	18.22	14.43	6.36

Table.3 Economics of the ecofriendly approach of *Alternaria* blight management in tomato

Treatments	**Excess produce over control (q/ha)**	**Gross expenditure over control (Rs/ha)**	**Gross return over control (Rs/ha)**	**Net return over control (Rs/ha)**	**B:C ratio**
T_1: Removal of infected lower leaves, staking of plants	58.0	4450	46,400	41,950	9.4
T_2: Seed priming with Sanjeevani	62.4	4220	49,920	45,700	10.8
T_3:T_1 + T_2	79.4	5815	63,520	57,705	9.9
T_4:T_1 + Spraying *Trichodermaviride*	90.8	6930	72,640	65,710	9.5
T_5:T_1 + Spraying *Pseudomonas fluoroscens*	85.5	7630	68,400	60,770	8.0
T_6:T_2 + Spraying *T. viride*	92.6	6240	74,080	67,840	10.9
T_7:T_2 + Spraying *P. fluoroscens*	95.4	6940	76,320	69,380	10.0
T_8 : T_3 + Spraying *T. viride*	110.4	8270	88,320	80,050	9.7
T_9 :T_3 + Spraying *P. fluoroscens*	106.9	8970	85,520	76,550	8.5
T_{10} : Control	-	-	-	-	-

Seed treatment with Sanjeevani along with foliar spray of *T. viride* (T_6) and seed treatment with Sanjeevani along with foliar spray of *P. fluroscens* (T_7) were also proved effective by reducing the disease by 78.0 per centand 73.0 per cent respectively as well as increasing the yield by 42.4 per cent and 43.7per cent respectively. However the yield obtained from T_6 (310.6q/ha) and T_7 (313.4q/ha) are statistically at par with each other. The minimum rotted fruits (13.3q/ha) were harvested from T8 as compared to 37.6q/ha from control plot.

Considering the effects of cultural practices T_1 i.e. removal of infected lower leaves and staking of plants could be able to reduce the disease by 50.2% and there is increase in fruit yield over control about 26.5% which recorded 1:9.7 C:B ratio and found to be the best in all respects. Effectiveness of *Pseudomonas fluoroscens* as a potent biocontrol agent has been demonstrated earlier by Babu *et al.,* (2000), Ngoc *et al.,* (2013) and Mahapatra and Swain (2013) which is in line with the present study. Foliar spraying with *Trichoderma viride* and *T. harzianum* were also successfully demonstrated to manage *Alternaria porri*, causing purple blotch of onion by Mishra and Gupta (2008).

Mahapatra and Swain (2013) reported 82.82% disease control by spraying with *T. viride* and 78.24% disease control by spraying with *P. fluoroscens* against pod rot of ground nut. The cultural practices like staking of the plants to minimize the incidence has been reported earlier by Bharadwaj *et al.,* (1995) and detachment of lower leaves by Rathee *et al.,* (2006) and Hooda *et al.,* (2008), which confirmed the present findings. Therefore, an economic, effective, ecofriendly and integrated approach has been taken to manage the early blight pathogen under Odisha condition.

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