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Assessment on management of late blight in tomato incited by *Phytophthora infestans*

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ABSTRACT :

Late blight incited by *Phytophthora infestans*is one of the most widelyspread and economically important disease of tomato. The present investigation was carried out to evaluate the efficacy of different fungicides and biocontrol agents for the management of the disease. Soil application of *Trichoderma viride* and *Pseudomonas fluorescens* 15 days before transplanting followed by prophylactic spray of Mancozeb (0.2%) 25 days after transplanting was found effective. Three sprays of fungicides *viz*., Metalaxyl+Mancozeb (0.2%), Fosetyl-Al (0.2%) and Dimethomorph (0.1%)+Polyram (0.2%) sprayed at regular intervals of ten, twenty and thirty days depending on the disease severity was found very effective in managing the disease.

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INTRODUCTION

The stramenopile *Phytophthora infestans*, commonly known as the Irish potato famine pathogen, is responsible for yield losses of $6·7 billion annually in potato and crop losses upto 100% in tomato (Nowicki *et al*., 2012) and has been considered a threat to global food security (Cooke *et al*., 2012). More than 150 years have elapsed since *Phytophthora infestans* caused the Irishpotato famine, but strategies for managing potato and tomato late blight often remainun sustainable and costly. In effect, *P. infestans* continues to cost billions of dollar sannually through losses in potato and tomato production and increased fungicide costs.

In India, potato and tomato are the most important vegetable crops, grown on 1·83 and 0·53 million ha, with a total annual production of 3·73 and 9·36 million tonnes, respectively (Chowdappa *et al*., 2011). Prior to 2006, late blight was an annual threat in the states of northern India, but it was not considered a major problem on potato

or tomato production in South India. Since the 2008 growing season, severe late blight epidemics have occurred on both tomato and potato crops in Karnataka, Tamil Nadu and Andhra Pradesh and have often caused 100% crop loss (Chowdappa *et al*., 2013). Although late blight has been known on potato in the Karnataka state of India since 1953, serious epidemics have only been observed on tomato since 2008.

Symptoms of tomato late blight include leaf lesions beginning as pale green or olive green areas that quickly enlarge to become brown-black, water-soaked and oily in appearance. Lesions on leaves can also produce pathogen sporulation which looks like white-gray fuzzy growth. Stems can also exhibit dark brown to black lesions with sporulation. Fruit symptoms begin small, but quickly develop into golden to chocolate brown firm lesions or spots that can appear sunken with distinct rings within them.

The cornerstone of disease management is the use of resistant crop cultivars. Unfortunately, durable resistance to late blight has not been available to growers, particularly in varieties that are inhigh demand by consumers. Effective management of late blight on tomato is influenced by the characteristics of the pathogen population. Several studies have demonstrated that severe epidemics of late blight were associated with the emergence of 'new' populations of *P. infestans* in which fungicide resistance or an ability to overcome host resistance had evolved (Lees *et al*, 2012). Management of late blight on tomato requires a multifaceted approach. The disease cannot be eliminated as it is soil borne and it can be managed by using integrated approaches to crop production and protection. The present investigation was undertaken to know the efficacy of different fungicides and bio control agents for the management of late blight in tomato. The present work is first of its kind with particular reference to late blight management in tomato in India.

MATERIAL AND METHODS

The field experiments for the efficacy of fungicides and bio control agents was conducted at, Krishi Vigyan Kendra, Bengaluru rural (KVK BRD) during *Rabi*, 2012-13, 2013-14 and Krishi Vigyan Kendra, Chikkaballapur district during 2012-13. The experiments were laid out in Randomized Block Design with three replications and seven treatments using tomato hybrid NS -501. The details of treatment combinations are given hereunder.

Treatments	Description
T_1	**Farmers practice (FP)-** Mancozeb (0.2%), Dimethomorph (0.1%) + Polyram (0.2%), CoC(0.3%), Sectin (0.3%), Metalaxyl+ Mancozeb(0.2%), Chlorothalonil (0.2%), Cymoxanil+Mancozeb (0.3%), CoH, Propineb (0.2%)
T_2	**Recommended practice (RP)-**Prophylatic Mancozeb (0.2%) 2 times Metalaxyl+ Mancozeb (0.2%), CoC (0.3%) Fenamidon + Mancozeb (0.2%)
T_3	**Alternate practice (AP)-**Soil application of *Trichoderma viride* and *Pseudomonas fluorescens*, Prophylactic–Mancozeb (0.2%), Metalaxyl+Mancozeb (0.2%), Fosetyl Al (0.2%), Dimethomorph (0.1%) +Polyram (0.2%)

Trichoderma viride and *Pseudomonas fluorescens* were mixed with FYM and allowed to multiply with proper moisture in it for 15 days. These were applied to field just before planting. Fungicide application treatments were done by Knapsacksprayer. Prophylactic spray of Mancozeb (0.2%) was given 25 days after transplanting. Three sprays of fungicides *viz*., Metalaxyl+Mancozeb (0.2%), Fosetyl-Al (0.2%) and Dimethomorph (0.1%)+Polyram (0.2%) were applied at regular intervals of ten, twenty and thirty days depending on the disease severity. Data on the diseasese verity was recorded after every ten days intervals starting from 30 days after transplanting. In each plot disease severity were scored and data were converted into per cent disease index (PDI). Each treatment was harvested separately and yield per plot was recorded further benefit : cost ratio was calculated. Yield data were pooled from all the harvests of each plot and expressed as tons/ha.

Statistical analysis :

The disease severity data was arcsine transformed before analysis of variance (ANOVA). Recorded data were subjected to statistical analysis using ANOVA of SAS statistical data analysis software. Duncan's multiple range tests was used to determine the most significant treatment.

RESULTS AND DISCUSSION

The data on per cent disease severity of late blight was recorded periodically from 30 to 80 days after planting (DAP) with an interval of 10 days (Table 1, 2 and 3). Data on disease severity showed that

Table 1: Per cent disease severity and yield data of on farm testing conducted on integrated management of late blight of tomato during *Rabi* 2012-13 at Bengaluru rural district

Demonstration number	Observations on per cent disease severity						Average per cent disease severity	Yield (kg/ac)	Yield (t/ha)
	30 DAT	40 DAT	50 DAT	60 DAT	70 DAT	80 DAT			
T_1 (FP)	21.5 (27.48)	19.7 (26.07)	18.0 (24.98)	16.1 (23.52)	13.8 (21.67)	10.9 (19.18)	16.66 (23.97)	10.08	50.42
T_2 (RP)	19.4 (25.93)	17.6 (24.94)	15.1 (22.70)	12.8 (20.81)	10.4 (18.66)	7.8 (16.12)	13.84 (21.66)	10.85	54.28
T_3 (AP)	17.4 (24.44)	15.2 (22.89)	13.0 (20.94)	19.6 (18.78)	8.4 (16.75)	5.8 (13.82)	11.54 (19.71)	11.25	56.25
S.E.±	0.19	0.33	0.38	0.47	0.39	0.372	0.24	0.078	0.39
C.D. (P=0.05)	0.56	0.96	1.121	1.39	1.14	1.11	0.71	0.23	1.17
CV	2.31	4.21	5.22	7.03	6.40	7.18	3.48	2.29	2.31

Table 2: Per cent disease severity and yield data of on farm testing conducted on integrated management of late blight of tomato during *Rabi* 2013-14 at Bengaluru rural district

Demonstration number	Observations on Per cent disease severity						Average per cent disease severity	Yield (kg/ac)	Yield (t/ha)
	30 DAT	40 DAT	50 DAT	60 DAT	70 DAT	80 DAT			
T_1 (FP)	21.71(27.70)	20 (26.27)	18.0 (25.36)	16.0 (23.51)	13.85 (21.76)	10.57 (18.90)	16.75 (24.69)	10.12	50.87
T_2 (RP)	19.85 (26.36)	18.28 (24.83)	15.28 (23.24)	13.42(21.39)	11.14 (19.62)	8.0 (16.35)	14.4 (22.68)	10.75	54.63
T_3 (AP)	17.71 (24.78)	15.57 (23.73)	13.71 (21.13)	10.71(19.03)	8.57 (16.96)	6.0 (14.07)	11.71 (19.92)	11.14	56.94
S.E.±	0.23	0.63	0.49	0.58	0.49	0.44	0.46	0.09	0.44
C.D. (P=0.05)	0.71	1.94	1.52	1.78	1.50	1.35	1.42	0.28	1.37
CV	2.31	6.69	5.60	7.18	6.63	7.02	5.44	2.26	2.17

Table 3: Per cent disease severity and yield data of on farm testing conducted on integrated management of late blight of tomato during *Rabi* 2012-13 at Chikkaballapur district

Demonstration number	Observations on per cent disease severity						Average per cent disease severity	Yield (kg/ac)	Yield (t/ha)
	30 DAT	40 DAT	50 DAT	60 DAT	70 DAT	80 DAT			
T_1	24.4 (29.56)	19.6 (26.26)	16.4 (23.86)	13.4 (21.45)	11. 2 (19.47)	9.4 (17.77)	15.07 (22.77)	10.123	52.186
T_2	21 (27.25)	16.4 (23.88)	14.6 (22.44)	12 (20.21)	10 (18.39)	8.4 (16.76)	13.73 (21.73)	10.746	52.384
T_3	19.2 (25.96)	13.6 (21.62)	11.6 (19.88)	9.6 (18.00)	7.6 (15.97)	6.4 (14.56)	11.33 (19.65)	11.144	54.412
S.E.±	0.225	0.379	0.425	0.491	0.365	0.360	0.498	0.125	0.623
C.D. (P=0.05)	0.732	1.236	1.388	1.602	1.190	1.174	1.624	NS	NS
CV	1.82	3.54	4.31	5.52	4.55	4.92	5.21	2.63	2.63

NS= Non-significant

Table 4: Pooled data of per cent disease index and yield of KVK BRD and KVK Chikkaballapur during 2012-13 and 2013-14

Treatment details	Treatments	Average per cent disease index						Pooled PDI	Pooled yield
		2012-13		2013-14		2012-13			
		PDI	Yield (t/ha)	PDI	Yield (t/ha)	PDI	Yield (t/ha)		
T_1	Farmers practice	16.66 (23.97)	50.420	16.75 (24.69)	50.871	15.07 (22.77)	52.186	23.810	51.159
T_2	Recommended practice	13.84 (21.66)	54.275	14.4(22.68)	54.629	13.73 (21.73)	52.384	22.023	53.763
T_3	Alternate practice	11.54 (19.71)	56.245	11.71 (19.92)	56.943	11.33 (19.65)	54.412	19.760	55.867
S.E.±		0.240	0.393	0.461	0.444	0.498	0.623	0.2732	0.707
C.D. (P=0.05)		0.712	1.166	1.422	1.370	1.624	NS	1.073	2.778
CV		3.48	2.31	5.44	2.17	5.21	2.63	2.16	2.29

Table 5: Economics of treatments evaluated for the management of Late blight in tomato

Treatments	Yield (kg/ha)	Gross returns (Rs.21/kg)	Cost of cultivation/ha	Marginal cost (Rs.)	Total cost (Rs.)	B:C ratio (GR/TC)	Marginal returns (Rs.)
T_1 (Control)	5115.9	107433.9	36000	20960	56960	1.88	-
T_2 (Recommended)	5376.3	112902.3	36000	8350	44350	2.54	5468.4
T_3 (Evaluated)	5586.7	117320.7	36000	8450	44450	2.63	9886.8

biocontrol agents and fungicide tested reduced the disease intensity significantly compared to control. All the treatments showed different level of reaction to late blight of tomato compared to control. The least per cent disease severity was recorded in T_3 and T_2 treatment with mean values of 11.54 and 13.84 per cent, respectively during *Rabi* 2012-13 in experimental plot of Krishi Vigyan Kendra, Bengaluru rural (Table 1). Therefore, in comparisons, the highest per cent final disease severity (16.66%) was recorded from control plot. There were significant differences within treatments on yield at study location. All treatments were exceeds the control plots. The maximum yield (56.25 tons/ha) was recorded from T_3 treatment compared to check plot (50.42 t/ha). During *Rabi* 2013-14 the least disease severity was recorded in T_2 and T_3 treatments (11.71% and 14.4%), respectively compared to control (16.75%) (Table 2). An yield of 56.94 t/ha was recorded from T_3 treatment compared to check plot (50.87 t/ha). Similarly during *Rabi* 2012- 13the least disease severity was recorded in T_2 and T_3 treatments (11.33% and 13.42%), respectively compared to control (13.73%) (Table 3). Maximum yield was obtained in T_3 treatment (54.41 t/ha) compared to check plot (52.19 t/ha).

Mancozeb as effective fungicide for the management of late blight and maximum fruit yield was reported by several workers (Sobolewski and Robak, 2004 and Chourasiya *et al*., 2013). Results of the present study showed that all fungicide treatments significantly controlled the late blight infection on tomato as compared to control.

Capriotti *et al*. (2005) reported the use of cabriotop- a combination productof pyraclostrobin+metiram was effective for both earlyblight and late blight. Duarte *et al*. (2007) have observed the positive effect from the combination of dimethomorph and chlorothalonil, succeeded bymetiram, compared to the combination of metalaxyl and chlorothalonil, succeeded by metiram.

The pooled data (Table 4) indicated that, the average per cent disease index was 19.76 per cent and 22.02 per cent, respectively in T_3 and T_2 treatments whereas the per cent disease index of 23.81 per cent was recorded in T_1 treatment. The pooled data revealed that the yield was highest in T_3 treatment (55.87 t/ha) and the least yield was recorded in control (51.16 t/ha) (Table 4).

From the pooled data of three season, it is evident that benefit: cost ratio of 2.63 was recorded in T_3 treatment and the least was noticed in control plot (1.88) A net income of Rs. 117320 /ha by investing Rs. 36000 / ha was realized in T_3 treatment compared to control (Table 5).

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