Management of Early Blight of Tomato (*Alternaria solani* Ellis and Martin) By Chemicals and biocontrol agents under field condition

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Early blight is a major production constraint in tomato wherever this crop is grown and it accounts for loss in tomatoes ranging from 5 to 50% world wide. Therefore, to manage the disease effectively a study was conducted to evaluate the bioefficacy of different fungicides *viz*. mancozeb, chlorothalonil, copper hydroxide, ziram, metalaxyl 8% + mancozeb 64%, dimethomorph 9% + mancozeb 60%, fenamidone, fosetyl Al + propineb,cymoxanil 8% + mancozeb 64% and two bioagents *viz*. *Pseudomonas fluorescens* and *Trichoderma viride* against Early blight of tomato during four consecutive years from 2009 to 2013 at AICRP on Vegetable Crops, OUAT, Bhubaneswar during *rabi* season. Tomato variety Utkal Kumari was transplanted and the trial was laid out in a randomized block design (RBD) with twelve treatments and three replications in a plot size of 3.0 m x 2.7 m and with a spacing of 50 cm x 40 cm. Among the 12 (twelve) tested treatments including control, all the treatments significantly reduced the Early blight disease intensity as compared to control. Mancozeb @ 0.2% (T_1) was found to be most effective in reducing the disease intensity (mean PDI-7.85) which significantly varied from control. The same treatment also registered maximum percent disease reduction over control (84.87%) corresponding to the maximum mean fruit yield (336.7q/ha) with B:C ratio of 3.5. However, the control plot recorded maximum mean disease intensity (PDI- 51.89) with minimum mean fruit yield (214.4 q/ha). The bioagents *viz*. *Pseudomonas fluorescens and Trichoderma viride* also significantly reduced the disease intensity as compared to control but both the treatments were at par in minimising the disease intensity . No phytotoxic effects such as stunting, chlorosis, necrosis, discolouration, blackening and burning / malformation were observed.

Key words: Bio efficacy, fungicides, biocontrol agents, Early blight, tomato, *Alternaria solani*, phytotoxicity

INTRODUCTION

Tomato (*Solanum lycopersicum*) is one of the most popular vegetables grown all over the world for its fleshy fruits. It is native to South America and is widely cultivated in 140 countries of the world with an annual production of 16826000 t (Anonymous, 2011). Tomato is known as productive as well as protective food and consumed in our daily life and is a good source of antioxidants (Sgherri *et al*. 2008). It is a rich source of vitamin A and C, it also contains minerals like iron, phosphorous and lycopene and beta carotene pigments. The estimated area and production of tomato in India are about 3,50,000 ha and 53,00,000 tons respectively (Anonymous, 2010). But the most important prob-

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lems in respect of quality and quantity of tomato production are that it is vulnerable to infection by variety of fungal, bacterial, viral diseases and around 200 diseases have been reported on tomato. Among these diseases, *Alternaria* leaf blight of tomato caused by *Alternaria solani* is the worst damaging one and it accounts for loss in tomatoes ranging from 5 to 50% (Anonymous,2010)world wide. *Alternaria solani* (Ellis and Martin) is a soil inhabiting air borne pathogen responsible for leaf blight, collar rot and fruit rot of tomato. It is an important disease of tropical and sub tropical areas. Distinctive bulls eye pattern of leaf spot with concentric rings of spores surrounded by halo of chlorotic leaf area are common. The pathogen causes infection on leaves, stems, petioles, twigs and fruits as well as leads to the reduction of photosynthetic area, defoliation, drying of twigs premature fruit drop which ultimately reduce the yield. The disease, if favoured by high temperature and high humidity and plants are more susceptible to the blight infection during fruiting period.Several fungicides have been recommended against *Alternaria* blight and play important role in management of the disease. The present investigation has been carried out using some new formulation along with bio agents for their bio efficacy and phytotoxicity against *Alternaria* blight of tomato disease.

MATERIALS AND METHODS

Field experiments were conducted to evaluate the bio efficacy of different fungicides along with bioagents against Early blight of tomato(*Alternaria solani*) disease under field condition in four consecutive years from 2009 to 2013 at experimental field of AICRP on Vegetable Crops, OUAT, Bhubaneswar during *rabi* season. Tomato variety Utkal Kumari was transplanted and the trial was laid out in a randomized block design (RBD) with twelve treatments and three replications in a plot size of 3.0 m x 2.7 m and with a spacing of 50 cm x 40 cm.The experiments consisted with twelve treatments viz.T_1- mancozeb,T_2- chlorothalonil, T_3- copper hydroxide,T_4- ziram, T_5-metalaxyl 8% + mancozeb 64%,T_6- dimethomorph 9% + mancozeb 60%, T_7-fenamidone, T_8-fosetyl Al + propineb, , T_9- *Pseudomonas fluorescens* ,T_{10}-cymoxanil 8% + mancozeb 64% T_{11}-*Trichoderma viride* and T_{12}- control.

Three sprayings were given at 10 days intervals at the onset of the disease. The recommended package of practices were followed for the trial. The observation on the disease incidence was recorded after 10 days of each spray. The severity of Early blight of tomato was recorded by using 0 to 5 scale i.e 0= no infection,1= 0.1-5.0% area infected,2= 5.1-10.0 % area infected, 3= 10.1-25.0% area infected,4= 25.1-50.0% area infected and 5= >50% area infected. Five infected plants were selected randomly from each plot and five leaves were selected from each selected plant for scoring the disease intensity. Finally per cent disease index (PDI) was calculated by using following formula.

$$PDI = \frac{\text{Sum of all numerical ratings}}{\text{Total no of leaves observed maximum scale}} \times 100$$

And the data were statistically analysed to find out the significant of variation among the treatments.The different fungicides and bio agents were sprayed at different doses as mentioned earlier. The phytotoxicity symtoms were recorded a weak after last spray on the following parameters viz. stunting, chlorosis, necrosis, discolouration, blackening and burning / malformation.

RESULTS AND DISCUSSION

The results obtained during the present investigation in respect of disease intensity and yield attributes of tomato are presented below.

Effect of fungicides and bio agents on the disease intensity of Early blight of tomato

Among the different tested fungicides and bio agents have differed in respect of disease intensity (%) and yield(q/ha). The lowest (7.85%) disease intensity was recorded with mancozeb@0.2% followed by chlorothalonil @ 0.2% (9.25%) was found to be the next best treatment in respect of reducing the disease intensity of Early blight of tomato.The treatments varied significantly from control. While the highest (51.89%) disease intensity was recorded in control plot followed by *Pseudomonas fluorescens* @ 0.2% (24.93%). Among the fungicides and bio agents mancozeb @ 0.2% was found to be best treatment to reduce the percent didease intensity of Early blight of tomato.

Effect of fungicides and bio agents on the yield of Early blight of tomato

The present study on effect of fungicides and bioagents on the disease intensity and fruit yield revealed that fruit yield obtained from fungicides and bio agents treated plants significantly differed from

Table 1 : Effect of different fungicides and biocontrol agents on disease intensity of Early blight and fruit yield (q/ha) of tomato (Pooled)

Treatments	Disease intensity (PDI)	% disease control	Fruit yield(q/ha)	% fruit yield increase over control	Benefit:Cost
T_1 Mancozeb 75% WP @ 0.2%	7.85(16.15)	84.87	336.7	57.04	3.55
T_2 Chlorothalonil 75% WP@ 0.2%	9.25(17.57)	82.17	320.7	49.58	3.19
T_3 Copper hydroxide 50% WP @ 0.2%	15.15(22.86)	70.80	305.6	42.53	3.14
T_4 Ziram 27% SL@ 0.02%	17.97(25.07)	65.36	291.4	35.91	3.09
T_5 Metalaxyl 8% + Mancozeb 64% WP @ 0.2%	11.79(20.06)	77.27	275.2	28.35	2.70
T_6 Dimethomorph 9% + Mancozeb 60% WP @ 0.1% + 0.2%	18.90(25.65)	63.57	288.4	34.51	2.99
T_7 Fenamidone (Section) @ 0.3%	11.72(20.00)	77.41	313.1	46.03	3.01
T_8 Fosetyl Al + Propineb @ 0.2%	18.20(25.08)	64.92	281.9	31.48	2.82
T_9 *Pseudomonas fluorescens* @ 0.2%	24.93(29.91)	51.95	256.2	19.49	2.83
T_{10} Cymoxanil 8% + Mancozeb 64% WP@ 0.2%	16.18(23.63)	68.81	255.1	18.98	2.53
T_{11} *Trichoderma viride* @ 0.2%	22.94(28.59)	55.79	254.7	18.79	2.88
T_{12} Control	51.89(46.09)	-	214.4	-	2.45
C.D. (0.05)	6.42	-	18.28	-	-

Figures in parentheses are angular transformed values

untreated control plot. Maximum fruit yield (336.7q/ha) was obtained from the plots treated with mancozeb @ 0.2% which was at par with treatment chlorothalonil @ 0.2% in respect of yield (320.7 q/ha). While the lowest fruit yield (214.4 q/ha) was obtained from untreated control plots. Economics of three sprays of different fungicides and bio agents revealed that mancozeb @ 0.2% not only effectively reduced the disease intensity but also registered highest cost benefit ratio (3.55).There were no phytotoxicity symptoms viz. stunting, chlorosis, necrosis, discolouration, blackening and burning / malformation were recorded during the course of study.

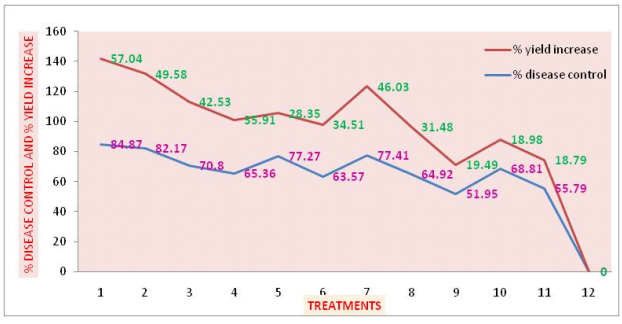

Fig. 1 : % Disease control and % yield increase as influenced by different treatments

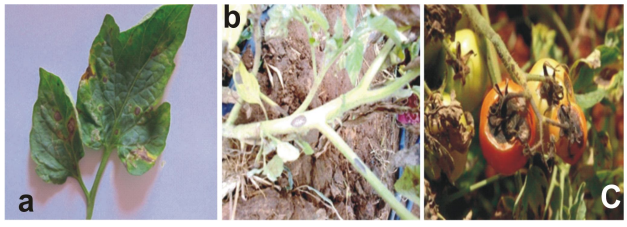

Fig. 2 : Symptoms of Early blight a. Leaf infection b. Stem infection c. Fruit infection

In the present study, the minimum disease intensity of Early blight and maximum yield was found when mancozeb @ 0.2% was used as foliar spray.The probable reason for such finding may

be that, mancozeb would have affected the spore germination and mycelia development, which may have resulted in the inhibition of disease producing activity of pathogen in the plant (Chourasia *et al*, 2013). Prasad *et al,* (2003) and Hooda *et al,* (2008) also reported the same trends that mancozeb was the most effective fungicide recording minimum disease intensity against early blight of tomato

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