INTERNATIONAL JOURNAL OF PLANT PROTECTION / VOLUME 5 | ISSUE 2 | OCTOBER, 2012 | 413-416

RESEARCH ARTICLE

Efficacy of fungicides in the management of early blight of tomato (*Alternaria solani*)

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ARITCLE INFO

Received : 03.08.2012
Revised : 25.08.2012
Accepted : 27.09.2012

Key **W**ords :
Early blight,
Alternaria soloni,
Fungicide, Tomato

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ABSTRACT

Early blight caused by *Alternaria solani* is a serious disease of tomato affecting the yield and quality of fruits. *In vitro* and field experiments were conducted to evaluate the efficacy of different fungicides, alone and in combinations with Mancozeb(0.2%), Zineb (0.2%), Ridomil MZ (0.2%) , Saaf (0.05%), copper oxychloride (0.2%) and Thiophanate methyl (0.1%) against early blight of tomato. The highest degree of mycelium inhibition was observed with Mancozeb, followed by Zineb, Saaf and Ridomil MZ-72. Among combination of systemic and non-systemic fungicides, maximum growth inhibition was recorded in Saaf (Carbendazim + Mancozeb at 0.05 % concentration) followed by Ridomil MZ-72 (Metalaxyl + Mancozeb at 0.2 per cent concentration. In field evaluation of fungicides, Mancozeb was found most effective at 0.2 per cent concentration showing least per cent disease index of 20.38 per cent as against 57.63 per cent in control, followed by Zineb and Saaf. Mancozeb recorded highest yield (294.86 q/ha) followed by Saaf, Zineb and Ridomil MZ-72.

How to view point the article : Yadav, Om Prakash and Dabbas, M.R. (2012). Efficacy of fungicides in the management of early blight of tomato (*Alternaria solani*). *Internat. J. Plant Protec.*, **5**(2) : 413-416.

INTRODUCTION

Early blight is the major disease of tomato caused by *Alternaria solani* (Ellis and Martin) Sorauer. The disease in severe cases can lead to complete defoliation and is most damaging on tomato in regions with heavy dew, rainfall, high humidity, and fairly high temperatures (24-29°C). *Alternaria solani* causes disease on foliage (early blight), basal stems of seedlings (collar rot), lesions on stems of adult plants (stem lesions), and fruits (fruit rot) of tomato (Chaerani and Voorrips, 2006). Yield losses up to 79 per cent from early blight damage have been reported from Canada, India, United States and Nigeria (Basu, 1974, Datar and Mayee, 1981; Gwary and Nahunnaro ,1998). During the last few years early blight has been occurring almost every year primarily due to the soil-borne survival of the fungus, local overwintering / oversummering of inoculum, cultivation of susceptible varieties and favourable environmental conditions. Only a few tomato varieties are reported to be tolerant to early blight, but they have not perform well in field. Fungicides are regularly and intensively applied to reduce yield losses, because cultivars that combine early blight resistance and good agronomic or commercial characteristics are not available. Most of the fungicides like Mancozeb, Zineb, Ridomil MZ-72, Saaf and copper oxychloride, Propiconazole, Thiophenatemethyl have been found effective for the control of the disease under field condition (Singh and Singh, 2002; Mishra, 2012) Early blight is prevalent in almost all tomato growing areas of U.P., but not much more information is available for the management of early blight in tomato.

The aim of the present study is to compare the effect of some selected fungicides alone or combination on reducing mycelial growth and the natural infection of early blight of tomato.

MATERIALS AND METHODS

Isolation of pathogen :

Alternaria. solani conidia that were taken from infected tissue of diseased tomato leaves were inoculated on water agar medium (2%; 2 g agar/100 ml sterile distillate water). The plates were incubated at 25°C for 3 days. Single spore colonies were transferred to the Petri dishes containing Potato dextrose agar (PDA) to obtain pure culture of the pathogen.

Evaluation of fungicides :

Systemic and non-systemic fungicides *viz.*, Mancozeb 75 per cent WP (Indofil M-45), Zineb 75 per cent WP (Indofil Z-78), Ridomil MZ 72 per cent WP (Metalaxyl 8% + Mancozeb 64%), Saaf 75% WP (Carbendazim 12%+ Mancozeb 63%), copper oxychloride 50 per cent WP (Blue diamond) and Thiophanatemethyl 70 per cent WP (Roko) were evaluated *in vitro* and *in vivo* against the pathogen. Fungicides were used at the dosese: Mancozeb 0.2 per cent, Zineb 0.2 per cent, Ridomil MZ-72 0.2 per cent, Saaf 0.05 per cent, Copperoxychloride-0.2 per cent and Thiophanate methyl 0.1 per cent .

Effect of fungicides on the linear growth of *Alternaria solani* :

Systemic and non-systemic fungicides were evaluated for their efficacy on mycelial growth of *Alternaria solani* by food poisoning technique. Appropriate (20 mg) quantity of each fungicide was separately dispensed in molten sterilized Potato dextrose agar medium to make the desired concentrations for each fungicide. The mycelial discs of 5 mm diameter, taken from the periphery of 10 days-old culture of *Alternaria solani*, aseptically placed in the centre of solidified poisoned PDA in Petri plates and incubated at 25± 1 ^{0}C for 7 days. Four replications of each treatment were kept and control was maintained without adding any fungicide to the medium. The radial growth of pathogen was measured. The efficacy of a fungicide was expressed as per cent inhibition of mycelial growth over control that was calculated by using the formula suggested by Arora and Dwivedi (1979) :

$$I = (C - T) / C \times 100$$

where,

I = Per cent inhibition

C = Radial growth in control

T = Radial growth in treatment

The per cent values were converted to arc sine values before statistical analysis.

Field experiments :

The field experiment was laid out in Completely Randomized Block Design (RBD) with 7 treatments and 4 replications during 2007-2008 at Research farm of Department of Vegetable Science, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur , U.P. under natural conditions of infection by early blight. Inoculum was present naturally at the test sites. Tomato (Azad T-6) seedlings were raised in nursery beds and 30 days old seedlings were transplanted into the field. Distance between row to row and plant to plant was 60 cm and 50 cm in 3 m ×2 m plot size. Four replicate plots were maintained for each treatment. Six fungicides *viz.,* Mancozeb, Zineb, Ridomil MZ-72, Saaf, copper oxychloride and Thiophanatemethyl were evaluated as three sequential sprays at an interval of 12 days. First spray of the fungicides was done immediately after the initial appearance of disease symptoms and control plot was sprayed by water. Ten plants were selected randomly in each plot and observation on disease severity was recorded individually using 0-5 rating scale (Table A) based on leaf area, stem and fruit covered by blight symptoms following the rating scale described by (Pandey *et al.,* 2003). Disease incidence was calculated on the basis of per cent of infected leaves and stems. Per cent disease index (PDI) was calculated as follows:

$$PDI = \frac{\text{Sum of all rating x100}}{\text{Total no. of observations x maximum rating grade}}$$

Table A : Scale for rating of early blight in tomato

Rating	Reaction description
0	Free from infection
1	< 10% surface area covering leaf, stem and fruit
2	11-25% foliage of plant covered with a few isolated spots
3	Many spots coalesced on the leaves, covering 26-50% surface area of plant
4	51-75% area of the plants infected, fruits also infected at peduncle end, defoliation and blightening started. Sunken lesions with prominent concentric rings on stems, petioles and fruits
5	< 75% area of plant part blighted, severe lesions on stem and fruit rotting on peduncle end

Observations on fruit yield per plot were also recorded.

Statistical analysis :

Analysis of variance (ANOVA) tests was performed on data to test for significant (P< 0.05; P<0.01) differences between

fungicides. Least significant difference (LSD) test was used to compare means of treatments. Percentage values were analyzed after arcsine transformation of the raw data.

RESULTS AND DISCUSSION

The results of the present study as well as relevant discussions habe been presented under following sub heads:

Effect of fungicides *in vitro* growth :

Among the fungicides, Mancozeb (98.15%) gave maximum inhibition of the mycelial growth of pathogen and proved to be the best and found statistically (= 0.05%) superior over rest of the fungicides and was followed by Saaf (92.89 %) and Zineb (90.69%). Least inhibition of mycelial growth was observed in Thiophanatemethyl (41.49 %). Among the combination of systemic and non-systemic fungicides, the significant maximum growth inhibition was recorded in Saaf (Carbendazim + Mancozeb) which inhibited the fungal growth 92.89 per cent. This was followed by Ridomil MZ-72 (Metalaxyl + Mancozeb) which inhibited 83.89 per cent fungal growth (Table 1). Patel and Chaudhary (2010) noted that mancozeb was an effective in inhibiting the mycelial growth of *Alternaria solani* at a minimum concentration of 0.1 per cent. They also reported Ridomil MZ-72 as most inhibitory to linear growth of *Alternaria solani* at 0.2 per cent.

Field experiments :

All the six fungicides were found effective against early blight in comparison to control in checking the disease intensity. The data on per cent disease index (PDI) of early leaf blight are presented in Table 2. From the data, it was observed that all the treatments differed significantly ($P< 0.001$) over unprotected check. Mancozeb was found most effective among fungicides showing least PDI (20.38%) and obtained maximum yield (294.86q) followed by Zineb (29.13%) Ridomil MZ-72 (31.63%) and Saaf (30.00%) as compared to 57.63 per cent in control. There was significant increase in fruit yield in fungicide treated plots over control. However, maximum yield (294.86 q/ha) was obtained in plots sprayed with Mancozeb, followed by Saaf (262.33q/ha), Zineb (261.60 q/ha) and Ridomil MZ-72 (246.77q/h). Yield was less in control (161.76 q/ h).

In the present studies, Mancozeb was found best among six fungicides tested showing least PDI. Mishra (2012) and Sudarshana *et al*.(2012) also reported foliar spray of 0.2 per cent Mancozeb as effective fungicide against early blight of tomato. Efficacy of Zineb and Ridomil MZ-72 has also been found very effective by various workers in reducing the disease (Singh and Singh, 2002; Patel and Chaudhary 2010). Combination of systemic and non-systemic fungicides like Ridomil MZ-72 (Metalaxyl + Mancozeb), Saaf (Carbendazim + Mancozeb) will be much cheaper and more effective in management of early blight of tomato. This strategy will also reduce the chances of evolution of new races of *Alternaria*

Table 1 : Per cent inhibition of mycelial growth of *Alternaria solani* by different systemetic and non-systemic fungicides

Sr.No.	Fungicides	Concentration (%)	Per cent inhibition over control
1.	Mancozeb	0.20	98.15 (82.18)*
2.	Zineb	0.20	90.69 (72.25)
3.	Ridomil MZ	0.20	83.89 (66.34)
4.	Saaf	0.05	92.89 (74.57)
5.	Copper oxychloride	0.20	82.98 (65.63)
6.	Thiophanate methyl	0.10	41.49 (40.09)
LSD(0.01)			1.93

*Figures in parenthesis indicate angular transformed value

Table 2 : Effect of different fungicides on early blight intensity and yield of tomato in field

Sr. No.	Fungicides	Concentration (%)	Per cent disease index (PDI)	Yield (q/ha)
1.	Mancozeb	0.2	20.38 (26.79)*	294.86
2.	Zineb	0.2	29.13 (32.59)	261.60
3.	Ridomil MZ	0.2	31.63 (34.19)	246.77
4.	Saaf	0.05	30.00 (33.19)	262.33
5.	Copper oxychloride	0.2	35.25 (36.42)	242.79
6.	Thiophanatemethyl	0.1	45.00 (42.12)	200.20
7.	Control	-	57.63 (49.39)	161.76
	LSD (5%)		3.41	4.44

*Figures in parenthesis indicate angular transformed values

solani against the systemic fungicides.

Acknowledgement :

The authors are grateful to the Head, Department of Plant Pathology, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur for providing necessary facilities to carry out the present investigation.

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