INTERNATIONAL JOURNAL OF PLANT PROTECTION / VOLUME 5 | ISSUE 2 | OCTOBER, 2012 | 201-206

IJPP

RESEARCH ARTICLE

Management of early blight (*Alternaria solani*) in tomato by integration of fungicides and cultural practices

■ RASHMI TEWARI* AND K. VISHUNAVAT

Department of Plant Pathology, College of Agriculture, G.B.Pant University of Agriculture and Technology, Pantnagar, U.S. NAGAR (UTTARAKHAND) INDIA

ARITCLE INFO

Received : 13.04.2012
Accepted : 06.07.2012

Key Words :
Early blight,
Tomato,
Alternaria solani,
Integrated management

*Corresponding author:
rashmipnt@gmail.com

ABSTRACT

Tomato (*Lycopersicon esculentum* Mill.) is the most widely cultivated vegetable crop in the world and early blight caused by *Alternaria solani* (Ell. and Martin) Jones and Grout is one of the major constraints for deterioration of quality of the crop. The pathogen is responsible for reducing the seed quality parameters as well as the yield of fruits. Seed treatment with fungicides enhanced germination and reduced seedling infection and thiram was found to be the best for seed treatment as it enhanced the germination and reduced seedling infection. Fungicides, along with cultural practices (inter cropping with marigold, mulching and stacking) were evaluated to develop an effective management strategy for early blight of tomato. Cultural practices when integrated with fungicides reduced the per cent disease index and increased the yield.

How to view point the article : Tewari, Rashmi and Vishunavat, K. (2012). Management of early blight (*Alternaria solani*) in tomato by integration of fungicides and cultural practices. *Internat. J. Plant Protec*., **5**(2) : 201-206.

INTRODUCTION

Tomato (*Lycopersicon esculentum* Mill.) is one of the most popular and widely grown vegetables in the world. By virtues of its many attributes, wider adoptability and versatility, tomato is considered as a favourite crop for research. Diseases are one of the most limiting factors for production of tomato. It reduces the quantity as well as market value of the product. Fungal pathogens are often more wide spread and cause substantial damages. Alternaria blight of tomato, popularly known as early blight is caused by a fungus, *Alternaria solani* (Ell. and Martin) Jones and Grout. It is common disease wherever tomatoes are grown and is one of the most destructive diseases causing significant qualitative and quantitative losses at any stage of plant growth including fruit and seed production. The pathogen is also responsible for causing storage losses during transit. Disease is favoured by warm temperature and extended periods of leaf wetness from dew, rainfall and crowded plantation. The plants are more susceptible to infection by the disease during fruiting period (Momel and Pemezny, 2006). In India, the disease is more severe during June to July sown crop than in the winter crop (Datar and Mayee, 1985). The disease is equally serious in the hills as well as in the plains. Present investigation was carried out to develop an effective management strategy against early blight of tomato using fungicides along with cultural practices.

MATERIALS AND METHODS

Experiments were conducted at Department of Plant Pathology, Crop Research Centre and Vegetable Research Centre, G. B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand (India). The experiments were laid in conducted two crop seasons during year 2006-2007 and 2007-2008. Tomato plants along with fruits showing early blight symptoms were carried from the fields at Vegetable Research Centre to laboratory and the pathogen was isolated from the infected plant parts. The pathogen was identified as *Alternaria solani* on the basis of its morphological characters.

Fungicides were screened *in vitro* against the linear growth of *A. solani* using poisoned food technique. Different concentrations of fungicides, *i.e.* 100, 250, 500, 1000 and 2000 ppm were tested. Certain volumes of the prepared fungicides were added to the proper amounts of potato dextrose agar (PDA) medium just before solidification to obtain the proposed concentrations, and then poured into sterilized Petri dishes (80 mm diameter). All dishes were inoculated in the centre with 5 mm discs taken from the edge of 8 day old *A. solani* culture. Three replicated dishes containing PDA only and inoculated with *A. solani* were used as check. All dishes were incubated at 26±1°C for 7 days, then the fungus linear growth was measured and the average was calculated.

For evaluating the fungicides for their effect on seed treatment, seeds extracted from naturally infected fruits were treated with fungicides (0.2 per cent) and treated seeds were stored overnight before use. Towel paper method was used for *in vitro* studies on effect on seed treatment on germination and seedling characters. One hundred seeds were placed in three layers of water-soaked towel paper. Seeds were placed equidistantly in rows on a set of towel paper rolled and incubated at 26 ± 1^0C for seven days. Three replications were maintained in each treatment. Untreated seeds served as check. Proper moisture in towel paper was maintained by adding sterilized water. Per cent germination, seed rot, seedling mortality, normal seedling, seedling infection and development of root and shoot length were recorded after seven days. Fungicides found to be the best were further evaluated under protected condition. Treated seeds were sown in the pots maintaining three replications in each treatment. Emergence count was recorded 15 days after sowing by counting the total number of emerged seedlings. Per cent emergence for each pot was calculated and seedling infection was also recorded.

Six fungicides (found to be the best against *A. solani in vitro*) alone and in combination *viz.,* carbendazim+mancozeb, propineb, copper oxychloride, thiram, metalaxyl+mancozeb, mancozeb and carbendazim @ 0.25 per cent concentration, were evaluated as prophylactic sprays in both treated (seed treatment with thiram @ 0.2 per cent) and untreated seeds, separately. Tomato seeds available at Vegetable Research Centre, G. B. Pant University of Agriculture and Technology, Pantnagar, were first sown in the properly prepared, raised nursery beds to grow seedlings and transplanted in the main field when attained a height of 10 – 15 cm and 4 – 6 true leaves. First spraying was done at the time of appearance of the disease followed by successive sprays at 10-day interval. Among the cultural practices mulching, staking and intercropping with marigold were applied. Mulching was done with maize and wheat straws, 25-30 days after transplanting of the crop. For intercropping, the seedlings of marigold which were 15 days older than tomato were planted in between. Staking was done by standing the plants with the help of wooden sticks. These practices were incorporated with the fungicidal sprays as to know the integrated effect of both on the disease severity and increase in yield. The interval between two successive sprays in this case was 15 days. Three replications for each treatment were maintained. Disease development was recorded on the basis of per cent infected leaves, stem and fruits.

The data on disease incidence were recorded using 0-5 class rating scale as described by Pandey *et al.* (2004). The per cent disease incidence (PDI) was calculated by using the following formula :

$$\text{PDI} = \frac{\text{Sum of all rating x 100}}{\text{Total no. of observations x Maximum rating grade}}$$

Fruit yield kg/plant was recorded and per cent increase in yield with respect to different treatment was calculated by using the following formula :

$$\text{Per cent increase in yield} = \frac{\text{Yield in treatment} - \text{yield in chechk plot}}{\text{Yield in check plot}} \text{x100}$$

The field experiments were conducted in Randomized Block Design (RBD) with three replications using susceptible cultivar 'Punjab Chhuhara'. All the data from experiments were pooled and subjected to standard statistical analysis as per Gomez and Gomez (1984).

RESULTS AND DISCUSSION

The important findings of the experiment studies under different irrigation levels, planting dates and mulching are presented in this chapter under appropriate heads:

In vitro effect of fungicides on linear growth of *Alternaria solani* :

Fungicides when screened *in vitro* by poisoned food technique at five concentrations to observe their effect on suppression of *A. solani*. The observations revealed that all the fungicides invariably inhibited the growth of the pathogen irrespective of their concentrations (Table 1). The increase in per cent inhibition was invariably proportional to the increase in the concentration of fungicides. At 100 ppm concentration, growth of *A. solani* was observed minimum in mancozeb followed by chlorothalonil and copper oxychloride while maximum growth in the same concentration was observed in benomyl after 7 days of incubation. At 250 ppm concentration, 100 per cent inhibition was observed in mancozeb and propineb and chlorthalonil were next to inhibiting the fungus. Maximum growth of the fungus was observed in bayleton followed by benomyl. No fungal growth was observed in propineb, chlorothalonil, copperoxychloride, mancozeb and metalaxyl + mancozeb at 500 ppm at 7^{th} day of incubation. In bayleton, captan, benomyl and bavistin, 100 per cent inhibition was not observed even in higher concentration at 2000 ppm. The result revealed that mancozeb completely inhibited the fungal growth and chlorothalonil and copper oxychloride reduced to minimum at 250 ppm concentration, propineb, thiram and carbendazim + mancozeb were found next in the order of efficacy against the pathogen. Prasad and Naik (2003) also reported that mancozeb showed considerable amount of growth inhibition of *A. solani* under *in vitro* condition. The principle involved in this technique is to poison the nutrient medium with the fungitoxicant and then allow the test fungus to grow on such medium. These fungicides possess specific modes of action by inhibiting the several biosynthetic processes of the pathogen.

Effect of seed treatment with fungicides on seed germination and seedling characters :

A. solani has been found to affect the seed quality of tomato. Infected seeds transmit the disease to seedlings as seedling infection was observed in the untreated seeds. The pathogen was found to be responsible for reducing the germination as well as causing seedling infection which leads to severe disease in the standing crop. There was no difference in the visual appearance except mild discoloration but the quality of seeds reduced, significantly. Krishna Swamy *et al.* (1998) have also reported reduction in seed germination due to *A. solani* which needs to be improved with various treatments. Naturally infected tomato seeds when treated with fungicides (0.2 per cent) enhanced the seed quality parameters as germination of the seeds and number of normal seedling was significantly higher and seed rot, seedling infection and seedling mortality were reduced in all the treatments as compared to check (Table 2). Maximum germination was observed in copper oxychloride followed by thiram treated seeds. Carbendazim, chlorothalonil, propineb and captan also increased seed germination. Seed rot was also reduced in treated seeds with minimum in thiram followed by

Table 1: *In vitro* effect of fungicides on linear growth of *Alternaria solani*

Fungicides	Linear growth (mm) at concentration (ppm)					
	100	250	500	1000	2000	Mean
Bayleton	56.0	53.0	49.0	44.0	18.0	44.0
Thiram	29.0	17.0	0.0	0.0	0.0	9.2
Captan	60.0	49.0	35.0	30.0	25.0	39.8
Propineb	19.0	6.0	0.0	0.0	0.0	5.0
Chlorothalonil	26.0	6.0	0.0	0.0	0.0	6.4
Copper oxychloride	28.0	10.0	0.0	0.0	0.0	7.6
Mancozeb	17.0	0.0	0.0	0.0	0.0	3.4
Metalaxyl + Mancozeb	48.0	26.0	0.0	0.0	0.0	14.8
Carbendazim + Mancozeb	27.0	21.0	21.0	0.0	0.0	13.8
Benomyl	57.0	43.0	43.0	27.0	23.0	38.6
Bavistin	26.0	23.0	23.0	22.0	17.0	22.2
Check	80.0	80.0	80.0	80.0	80.0	80.0
C.D. (0.05)	Fungicide (a) = 5.54, Concentration (b) = 8.59, a × b=1.92					

Table 2 : Effect of seed treatment with fungicides on germination and seedling infection

Treatments	Germination (per cent)	Seedling infection (per cent)
Carbendazim + Mancozeb	65.0 (53.7)	4.6 (12.4)
Propineb	78.0 (62.0)	3.6 (11.0)
Copper oxychloride	80.0 (63.4)	7.0 (15.3)
Thiram	79.0 (62.7)	1.6 (7.3)
Metalaxyl + Mancozeb	67.6 (55.3)	7.6 (16.0)
Mancozeb	70.3 (57.0)	6.6 (14.9)
Carbendazim	75.3 (60.2)	5.6 (13.7)
Check	54.0 (47.2)	12.3 (20.5)
C.D. (P=0.05)	3.72(2.34)	1.41(1.70)

*Figures in parenthesis are angular transformed values and statistics applied to them chlorothalonil. Significant difference in reduction in seedling infection was observed in all the fungicide treated seeds as compared to check. Minimum seedling infection was recorded in thiram followed by propineb treated seeds. Thiram resulted in maximum percentage of normal seedlings, minimum seedling mortality and maximum radical and plumule length. copper oxychloride and carbendazim were also good for emergence of normal seedlings. When the seeds were treated, significant difference in the root and shoot length of seedlings as compared to check was recorded with maximum of root length in thiram and shoot length in thirum and metalaxyl+mancozeb. Under glass house conditions, maximum seed germination was recorded with copper oxychloride @ 0.2 per cent followed by thiram with maximum reduction in seedling infection which was significantly higher as compared to all other treatments (Table 3). Reduction in the infection in growing seedlings by seed treatment was also noticed by Singh *et al*. (2000). Fungicidal seed treatment reduced the seedling infection and delayed infection of *Alternaria solani* in tomato.

Effect of prophylactic sprays of fungicides :

Among the fungicides tested, six sprays of mancozeb @ 0.25 per cent starting from the appearance of the disease symptoms (62 days after transplanting) at 10 day, intervals resulted in lowest disease severity in both treated and non treated seeds. Propineb was found to be the next in reducing

Table 3 : Effect on germination and seedling characters in naturally infected seeds using towel paper method

Sr. No.	Treatments	Total germination (%)	Seed rot (%)	Seedling infection (%)	Normal seedling (%)	Seedling mortality (%)	Root length (cm)	Shoot length (cm)
1.	Thiram	85.0 (67.2)	2.0 (9.9)	2.0 (7.9)	90.6 (72.2)	1.3 (6.5)	4.3	8.7
2.	Propineb	81.0 (64.2)	5.0 (12.9)	3.0 (9.9)	78.6 (62.5)	6.3 (14.6)	2.8	8.3
3.	Carbendazim + Mancozeb	73.0 (58.7)	3.0 (7.9)	4.0 (11.5)	70.6 (57.2)	2.3 (8.7)	2.0	5.8
4.	Copperoxy-chloride	88.0 (69.7)	3.0 (9.9)	4.0 (11.5)	86.6 (68.6)	2.3 (8.7)	2.8	7.6
5.	Carbendazim	84.0 (66.4)	3.6 (11.0)	4.0 (11.5)	81.6 (64.6)	2.3 (8.7)	2.5	8.3
6.	Metalaxyl + Mancozeb	78.0 (62.0)	4.0 (11.5)	4.0 (11.5)	75.6 (60.5)	4.0 (11.1)	3.7	8.9
7.	Mancozeb	76.0 (60.7)	4.0 (11.5)	4.0 (11.5)	73.6 (59.1)	2.3 (8. 6)	3.0	8.4
8.	Bayleton	76.0 (60.7)	7.0 (12.9)	6.0 (14.1)	73.3 (58.9)	2.6 (9.4)	3.1	4.1
9.	Benomyl	73.0 (59.7)	5.2 (11.0)	6.0 (14.1)	57.0 (49.0)	6.0 (14.1)	2.3	6.5
10.	Captan	81.0 (64.2)	9.3 (17.4)	7.0 (15.3)	75.0 (60.0)	6.0 (14.1)	3.1	6.2
11.	Chlorothalonil	83.0 (65.7)	2.6 (7.9)	8.0 (16.4)	77.0 (61.4)	2.3 (8.7)	3.1	7.9
12.	Check	63.0 (52.5)	19.3 (23.6)	15.6 (23.3)	60.6 (51.2)	2.3 (7.2)	2.1	6.2
	C.D. (0.05)	8.41(6.09)	1.59 (2.51)	1.56 (2.18)	2.23 (1.49)	2.12 (4.17)	0.17	0.24

Table 4: Effect of fungicides on disease severity and yield of tomato

Treatments	Per cent disease index	Yield (kg/plant)	Increase in yield (per cent)
Thiram	67.3 (56.4)	1.166	16.6
Carbendazim + Mancozeb	55.3 (48.9)	1.133	13.3
Chlorothalonil	48.6 (45.0)	1.200	20.0
Copper oxychloride	42.0 (41.2)	1.166	16.6
Propineb	39.3 (39.6)	1.300	30.0
Mancozeb	32.6 (35.6)	1.300	30.0
*Thiram	56.6 (49.6)	1.233	23.3
*Carbendazim + Mancozeb	52.6 (47.3)	1.166	16.6
*Chlorothalonil	44.6 (42.7)	1.233	23.3
*Copper oxychloride	41.3 (40.0)	1.200	20.0
*Propineb	38.0 (38.8)	1.333	33.3
*Mancozeb	31.3 (34.7)	1.366	36.6
*Check 1	70.6 (57.2)	1.033	3.3
Check 2	74.6 (59.7)	1.000	-
C.D. (0.05)	6.124(3.69)	0.186	

* Seed treatment with Thiram @ 0.2 per cent concentration

the disease severity in both the conditions. Disease severity was comparatively lesser in the plants where respective sprays of fungicides were done after seed treatment. The yield per plant improved significantly as compared to check in all the treatments. Maximum increase in yield was recorded in plants when sprayed with mancozeb followed by propineb. Seed treatment with thiram enhanced the number of fruits in the plants as fruit yield was higher up to 3-6.6 per cent per plant as compared to untreated plants (Table 4). Ashour, (2009) reported that fungicides were the most efficient in managing the natural infection of early blight. Sood and Sharma (2004) also reported that mancozeb was effective in reducing the disease severity of early blight with corresponding increase in number of fruits. In this study, seed treatment with thiram enhanced the efficacy of the fungicides.

Effect of cultural practices on early blight infection and yield:

The data on the effect of cultural practices on disease severity and yield indicated that disease severity was reduced significantly in all the treatments where as there was non-significant difference in yield when these practices were followed individually. However, the disease severity was reduced and per cent increase in yield was higher in all the treatments as compared to check (Table 5). Minimum disease severity and maximum per cent increase in yield was recorded in the plots where all these cultural practices were put together. Earlier workers, Millls *et al.* (2002) and Gomez *et al*. (2003) also reported the positive effect of each individual practice. In present study, the combined effect of intercropping with marigold, mulching and staking was found to be more effective as compared to check as well as the practices alone.

Combined effect of fungicides and cultural practices on early blight infection and yield :

When all the cultural practices were combined along with fungicides, the number of sprays reduced from seven to

Table 5: Effect of cultural practices on disease severity and yield

Sr. No.	Treatments	Per cent disease index	Yield (kg/plant)	Increase in yield (per cent)
1.	Intercropping with marigold	70.6 (57.2)	1.033	3.3
2.	Mulching	69.3 (56.3)	1.033	3.3
3.	Staking	68.6 (55.9)	1.066	6.6
4.	$T_1 + T_2 + T_3$	67.0 (55.5)	1.100	10.0
5.	Check	74.6 (59.7)	1.000	-
	C.D. (0.05)	1.417(0879)	0.149	

Table 6 : Combined effect of fungicides and cultural on early blight incidence and yield

Treatments	Per cent disease index	Yield (kg/plant)	Increase in yield (per cent)
Thiram	64.0 (53.1)	1.233	23.3
Carbendazim + Mancozeb	52.0 (46.1)	1.200	20.0
Chlorothalonil	45.3 (42.3)	1.266	26.6
Copper oxychloride	40.0 (39.2)	1.233	23.3
Propineb	36.0 (36.8)	1.366	36.6
Mancozeb	29.3 (32.7)	1.366	36.6
*Thiram	53.3 (46.9)	1.300	30.0
*Carbendazim + Mancozeb	49.3 (44.6)	1.233	23.3
*Chlorothalonil	41.3 (40.0)	1.300	30.0
*Copper oxychloride	38.6 (38.4)	1.366	36.6
*Propineb	34.6 (36.0)	1.400	40.0
*Mancozeb	28.0 (31.9)	1.433	43.3
*Check 1	66.6 (56.3)	1.166	16.6
Check 2	68.6 (57.2)	1.066	6.6
Check 3	74.6 (59.7)	1.000	-
C.D. (0.05)	5.63 (3.35)	0.21	

* Seed treatment with Thiram @ 0.2 per cent concentration, Check 1 = Intercropping, mulching and stacking with seed treatment
Check 2 = Intercropping, mulching and stacking without seed treatment, Check 3 = Without intercropping, mulching, stacking and seed treatment

five and the interval between two successive sprays was 15 days as the disease progress was relatively low. The integrated effect of cultural practices and spray of fungicides revealed that the disease severity was reduced and yield was increased significantly as compared to the plants where none of any treatment was given (Table 6). When all the three cultural practices were followed together, the affectivity of the fungicides enhanced as these fungicides showed better response in reducing the early blight incidence and increase in the yield as compared to that they response alone. In this case minimum disease severity and maximum increase in yield was recorded in crop sprayed with mancozeb in both treated and untreated seeds followed by propineb. The combined effect of cultural practices and fungicides were more affective as they have their positive individual effect in reducing the disease and increasing the yield.

Fungicides are considered as the shortest and efficient way of disease management. However, due to hazardous effects of the fungicidal residues in the plant products especially vegetables which are consumed after a short time of fungicide application, alternative methods of disease management are needed and/or make a schedule or a programme of using fungicides before fruit harvesting by a long period until occurring degradation to toxic component of the sprayed fungicides. Cultural practices may be an alternative for lowering disease hazards and reducing the number of sprays of fungicides. When these cultural practices are integrated with the fungicides, the effectivity of the fungicides enhances as number of sprays reduces and time interval between two successive sprays increases which may not only be quite safer than the fungicides sprayed alone but it also reduces the cost of cultivation.

REFERENCES

Ashour, A.M.A. (2009). A protocol suggested for managing tomato early blight. *Egypt. J. Phytopathol.*, **37**: 9-20.

Datar, V.V. and Mayee, C.D. (1985). Epidemiology of early blight of tomato caused by *Alternaria solani*. *Indian Phytopath.*, **34**: 434-437.

Gomez, R.O., Zavaleta Mejia, E., Gonzalez Hernandez, V.A., Livera Munoz, M. and Cardenas Soriano, E. (2003). Allelopathy and microclimatic modification of intercropping with marigold on tomato early blight disease development. *Field Crop Res.*, **83**: 27-34.

Gomez, R.J. and Gomez, A.A. (1984). Statistical procedures for agricultural research. (2nd Ed.) IRRI, Philippines. 680pp.

Krishna Swamy, K., Lokesh, S., Ramesh Babu, H.N. and Shetty, H.S. (1998). Studies on biology and transmission aspect of *Alternaria solani* in tomato seeds. *Ad. Plant Sci.*, **11**: 37-44.

Mills, D.J., Coffman, C.B., Teasdale, J.R., Everts, K.L., Abdul Baki A.A., Lydon, J. and Anderson, J.D. (2002). Foliar disease in fresh market tomato grown in differing bed strategies and fungicide spray programmes. *Plant Dis.*, **86**(9): 955-959.

Pandey, K.K., Pandey, P.K., Gautam, Kalloo and Banerjee, M.K. (2004). Resistance to early blight to tomato with respect to various parameters of disease epidemics. *J. General Pl. Pathol.*, **69**(6): 364-371.

Prasad, Y. and Naik, M.K. (2003). Evaluation of genotypes, fungicides and plant extracts against early blight of tomato caused by *Alternaria solani*. *Indian J. Pl.Prot.*, **31**(2): 49-53.

Singh, N.K., Saxena, R.P., Jaiswal, R.C. and Kumar, Pradeep (2000). Effect of fungicidal seed treatment and foliar sprays on early blight incidence, fruit characters and yield of tomato cv. Pusa Ruby. *J. Appl. Hort.*, **2**: 124-126.

Sood, R. and Sharma, R.L. (2004). Incidence of fruit rot (*Alternaria* spp.) of tomato in Himanchal Pradesh. *Plant Dis. Res.*, **19**:193-195.

■WEBLIOGRAPHY

Momel, T.M. and Pemezny, K.L. (2006). *Florida plant disease management guide: Tomato*. Florida Cooperation Extensive Service, Institute of Food and Agriculture Sciences, Gaine Ville, 32611 (*http\\edis.infas.ufl.edu*).

****