Research Article

MANAGEMENT OF TOMATO DISEASES IN PLASTIC HOUSE AT LAMJUNG

S.K. Neupane[1]* and G.B. K.C.[2]

ABSTRACT

An experiment was conducted in plastic houses at three farmers' field, each farmer as a replication, in three local levels (Sundarbazar, Gaunsahar and Besisahar) in Lamjung district during July to December 2017, to identify and manage major diseases of tomato (variety: Srijana) using chemicals and bio-pesticides. The treatments Bio-cure-B (*Pseudomonas fluorescens*: bio-fungicide) Bavistin (Carbendazim, systemic fungicide) and Dithane M-45 (Mancozeb, contact fungicide) were applied as foliar spray. Control plot was maintained without application of any treatment. Mainly four fungal diseases, early blight (*Alternaria solani*), late blight (*Phytopthora infestans*), powdery mildew (*Leveillula taurica*), septoria leaf spot (*Septoria lycopersici*) and one bacterial disease (*Xanthomonas campestris* pv. Vesicatoria) were recorded. Mancozeb showed the best to control the disease incidence and severity of early blight (25%, 6.33%), late blight (18.0%, 14.34%) and septorial leaf spot (11.67%, 11.55%) repectively followed by Carbendazim, and *P. fluorescens* over control. However, Carbendazim was the best to control powdery mildew (6.0%, 2.0%), followed by Mancozeb and *P. fluorescens* over control. There were no significant effect of pesticides on bacterial leaf spot, plant height, and leaf number but considerable variation in fungal diseases, yield and average fruit weight.

Keywords: *Management measures, plastic houses, tomato, tomato diseases*

INTRODUCTION

Tomato (*Lycopersicon esculentum*) is an important vegetable crop of family solanaceae and is one of the most remunerable and widely grown in the world. The world annual production of tomato during 2022 was 186.821 million t covering an area of 5.05 million ha with the productivity of 37.1 t per hectare (FAO, 2022). Tomato is one of the important vegetable crops in Nepal and is grown commercially in plains and hills for fresh consumption and processing to some extent (Rawal *et al*., 2017). In Nepal, tomato stands in third position after cauliflower and cabbage in terms of area (22,566 ha) and production (406,188 t) with average productivity 18 tons/ ha. (MOALD, 2020). It is also called as poor man's apple in Nepal (Ghimire *et al*., 2017). Although the terai region produces and sells more vegetables, vegetables grown in the hilly region have greater value; these vegetables are produced

[1] Prime Minister Agriculture Modernization Project, Project Implementation Unit, Gulmi
[2] National Academy of Science and Technology (NAST), Khumaltar, Lalitpur
*Email for ccorrespondence: shree.neupane2000@gmail.com

during the rainy season when prices are higher (NEAT, 2011). Tomatoes, which are actually a fruit vegetable, are carried with most of human health benefits. It contains a very powerful antioxidant called lycopene which purportedly fights the free radicals that can interfere with normal cell growth and activity (Bhowmik *et al*., 2012). Tomato cultivation in plastic house conditions favored the off season production making possible availability of tomato in all seasons in market.

There are several diseases on tomato caused by fungi, bacteria, viruses, nematodes and abiotic factors that are limiting its production and productivity (Balanchard, 1992). Early blight caused by late blight caused by Phytopthora infestans and Septoria leaf spot caused by *Septoria lycopersici* are the major fungal foliar diseases. Powdery mildew caused by *Leveillula taurica* is also an important foliar disease generally appearing in late season. Late blight of tomato (*Phytopthora infestans*) is considered to be the most devastating disease worldwide (Nelson, 2008).

To combat with diseases growers/farmers are using chemical fungicides haphazardly, but still satisfactory level of diseases control are not achieved by them. At the same time, the ultimate results of haphazard use of chemicals create health related problems, increase environmental pollution and yield loss also due to non- target fungicides application resulting in fungicide induced disease resurgence, the whole natural ecosystem is adversely affected and also financial burden increased to the poor farmers. Therefore, the objective of the study was to find out the effectiveness of most commonly used chemical fungicides and bio-fungicide for the management of major, foliar diseases of tomato grown under plastic houses. To identify the prevailing tomato diseases with their incidence and severity and compare the efficacy of chemical and bio-pesticides in the management of tomato diseases in plastic house at Lamjung, are the specific objectives of the study.

MATERIALS AND METHODS

An experiment was conducted in three plastic houses on three farmers' fields at three VDCs in Lamjung (Sundarbazar, Gaunsahar and Besisahar) during July to December, 2017. Mean area of each plastic house was 50 sq m (10 m x 5 m). The farmers selected were, Sukram Dulal from Besisahar, Jit Bahadur Gurung from Sundarbazar and Mangali B. K. from Gaunsahar.

After seed bed preparation, 5 gram seeds of "Srijana F1 hybrid" tomato were sown continuously in row in 1 cm depth with row to row spacing of 10 cm on 18th June, 2017. Twelve days old seedlings were uprooted and transplanted on the same bed for hardening. Each plastic house was taken as a replication where there were 4 plots/plastic house with a size of 5 m x 2 m and inter plot spacing 40 cm. The plots were slightly raised to avoid the water logging and flooding. Twenty five days old, 20 seedlings per plot and 80 seedlings per plastic house were transplanted on 12th July, 2017 in all the plastic houses. There were two rows/plot and planting distance was 80 cm row to row and 50 cm plant to plant.

Treatments

There were 4 treatments in the study, which were replicated at 3 times. The treatments were applied as Bio-cure-B (*Pseudomonas fluorescens*,75% WP, 1x10^8 CFU's/g)@ 5 g/l, Bavistin (Carbendazim 50% WP) @ 2 g/l and Dithane M 45 (Mancozeb, 80% WP) @ 2 g/l water were sprayed five times at seven days intervals after the appearance of the diseases.

Observation

Observations on plant height, leaf numbers, yield, disease incidence and severity were taken. Plant height and leaf number were recorded two times, first 10 days after transplanting and the second 15 days after the first observation. Disease scoring was done from the central four plants of each plot after the appearance of the disease. Each 3rd plant from both the ends among the 10 plants in a row is selected for the observation. Disease scoring of infected plants was done using the following standard scales.

Scale used for assessment of late blight (Mayee and Datar, 1986)
0= No symptoms, 1 = 1 - 10% leaf area infected, 2 = 11 - 25% leaf area infected, 3 = 26 - 50% leaf area infected, 4 = 51 - 75% leaf area infected and 5 = >75% area infected.
Scale used for assessment of Septoria leaf spot (Gul *et al.,* 2016)
0= Disease free leaf, 1 = 0-5% leaf area infected, 2 = 6-20% leaf area infected, 3 = 21-40% leaf area infected. 4 = 41-70% leaf area infected, 5 = more than 70% leaf area infected
Disease incidence and severity were calculated by using the following formulae

$$\text{Disease Incidence (\%)} = \frac{\text{Number of infected plant units}}{\text{Total number of plant units}} \times 100$$

$$\text{Disease severity (\%)} = \frac{\text{Area of plant tissue affected}}{\text{Total area}} \times 100$$

$$\text{Disease Index (\%)} = \frac{\text{Sum of all disease ratings}}{\text{Total no. of samples x maximum disease grade in the scale}} \times 100$$

These formulae were applied to all the numerical scales.

AUDPC was calculated by using the following formula (Das *et al*., 1992).

$$\text{AUDPC} = \sum_{i=1}^{n-1} \left[\left(\frac{X_{(i+1)} + X_i}{2} \right) \right] \left(T_{(i+1)} - T_i \right)$$

Where,

X_i = Disease intensity on the i^{th} date.
T_i = Days from transplanting to the date of disease scoring
n = number of dates on which disease was scored.

Laboratory Work

Preparation of Potato Dextrose Agar

Potato Dextrose Agar (PDA) was prepared in the laboratory of IAAS, Rampur, Chitwan, for the confirmation of potato diseases from the research plots.

Statistical Analysis

Data entry was done in MS-excel and analyzed using MSTATC (MSTAT, Michigan State University, USA). Mean values were compared by using analysis of variance, Duncan's Multiple Range Test and descriptive analysis.

RESULTS AND DISCUSSION

Mainly five major diseases were observed in tomato plants under plastic house during experimental period. They were four fungal diseases, early blight, late blight, Septoria leaf spot, powdery mildew and one bacterial leaf spot. Powdery mildew appeared in late season of cropping period. All the treatments except in bacterial leaf spot were significantly different from control as shown in the Tables 1, 2 and 3 below.

EFFECTS OF TREATMENTS ON DISEASE INCIDENCE AND SEVERITY

Early blight

Initial symptoms of early blight were appeared on 26th September, 2017. The disease was identified by the appearance of brown to dark, leathery, necrotic spots first on leaflets in a target board pattern. The pathogen was identified as *Alternaria solani* by its typical conidiophores and conidia under microscope. Older leaves of tomato were affected first and the disease progressed upwards. Finally the leaves dried up and dropped down. Walker (1952) reported that the spots were oval or angular in shape up to 0.3 or 0.4 cm diameter and there was usually a narrow chlorotic zone around the spot which later faded into the normal green color. Saxena (1988) noted the cultural variability of *A. solani* isolates on PDA and classified in to 4 distinct cultural groups based on types of growth, colony colour, colour of the substrate and growth rate. Due to variability in pathogenic isolates, prolonged active disease cycle phase and broad host range early blight is very difficult to manage (Chohan, 2015). FAST (Forecaster of Alternaria solani on Tomato) predictive system for initiating and timing fungicide sprays on tomato in Pennsylvania was developed (Madden *et al*., 1978). The FAST system uses leaf wetness, air temperature, relative humidity and rainfall to calculate daily severity, and rating values that quantitatively represent conditions favorable for development of early blight (Pscheidt and Stevenson, 1986).

Effect of treatments

The results of the experiment revealed that the least disease incidence and severity of early blight were recorded in Dithane M-45 treated plots (25.0% and 6.33%), followed by Bavistin (28.67% and 11.33%) and Bio-cure-B (34.67% and 15.66%) as compared to

Control (49.0% and 23.33%) respectively (Table 1 and 2). Choulwar and Datar (1992) reported the similar results in which the tested fungicides, copper oxychloride, mancozeb, carbendazim and captafol against early blight of tomato, mancozeb was the most effective in reducing disease severity and increasing the yield in cultivar Pusa Ruby.

Late blight

Symptoms of late blight caused by *P. infestans* were noticed on October 5, 2017, which were at the base of the petiole as water soaked lesions with ash or green colour in later days. The symptoms were also seen in green fruits which were rotted in late stage. The pathogen was identified with papillate lemon shaped sporangia developed in the lesions under moist conditions. The pre-disposing factors for the late blight (Krause *et al.*, 1975) are: night temperatur should be below the dew point for at least four hours; minimum temperature should 10 ^{0}C or slightly above, cloud on the next day and at least 0.1 mm rainfall during 24 hours.

Effect of treatments

The least incidence and severity of late blight was shown by Mancozeb (18.0% and 14.34%), followed by Bavistin (22.23% and 18.33%), and Bio- cure B (27.34% and 21.66%) respectively as compared to control (38.0% and 26.66%) (Tables 1 and 2).

Powdery mildew

The symptoms of powdery mildew caused by *Leveillula taurica* were appeared on November 3, 2017. The fungus produced a white talcum like covering on the lower leaves first and progressed toward upper leaves. The infected leaves became yellow and prematurely dried up. Correll (2014), stated that three fungal species (*L. taurica, Oidium lycopersici* and *Oidium neolycopersici*) cause powdery mildew in tomato. Germination of powdery mildew fungi may distinguish from other fungi is the manner in which water is bound with in the conidia (Somers,E., and J.G.Horsfall, 1966)

Effect of treatments

The least disease incidence and severity of powdery mildew was observed in Bavistin treated plots (6.0% and 2.0%) followed by Dithane M-5 (8.67% and 4.0%) and Bio-cure-B (12.33% and 4.67%) respectively as compared to control (15.0% and 7.67%) (Table 1 and 2).

Septorial leaf spot

The initial symptoms of Septoria leaf spot caused by *Septoria lycopersici* appeared on September 26, 2017. The symptoms were minute to small brownish spots on the lower leaves. As the spots grew larger, they became more or less circular in outline and showed definite brown colored margin with grey center in which minute fruiting bodies, pycnidia, were appeared and black circular spots were appeared on the fruits.

Effect of treatments:

The least disease incidence and severity of Septoria leaf spot was observed in Dithane M-45 treated plots (11.67.0% and 11.55%), followed by Bavistin (15.33.% and 16.0%), Bio-cure-B (20.67% and 19.33%) respectively as compared to control (32.33% and 24.33%) (Table 1 and 2).

Bacterial leaf spot

Bacterial leaf spot, caused by the bacterium *Xanthomonas campestris* pv. *vesicatoria*, was infected to tomato leafs and fruits. Spots appeared on leaves and stems were small (up to1⁄8 inch across), circular to irregular in shape, and have a slightly greasy feel. Unlike similar-sized spots caused by the fungus *S. lycopersicae*, those caused by the bacterial spot pathogen did not develop grayish brown centers. Warm, rainy weather favored rapid spread of bacterial spot. However, obtaining disease-free transplants is crucial for controlling the bacterial diseases, since the bacteria can be transmitted to seedlings from contaminated seeds and injury site. There was no significant effect of pesticides on bacterial leaf spot as compared to control.

Table 1. Effect of treatments on incidence of diseases in tomato in plastic house

Treatments	Incidence (%)				
	EB	LB	PM	BLS	SLS
Biocure B	34.67^{b}	27.34^{b}	12.33^{b}	38.67^{a}	20.67^{b}
Bavistin	28.67^{c}	22.23^{c}	6.00^{d}	33.00^{a}	15.33^{c}
Mancozeb	25.00^{d}	18.00^{d}	8.67^{c}	29.00^{a}	11.67^{d}
Control	49.00^{a}	38.00^{a}	15.00^{a}	39.00^{a}	32.33^{a}
SEm (±)	1.563	1.28	0.943	1.803	1.833
LSD (=0.05)	3.124	2.558	1.884	36.02	3.663
Probability	<.01**	<.01**	<.01**	NS	<.01**
CV (%)	4.6	4.8	9.0	5.2	9.2

Figures in the column with the same letter are not significantly different (p = 0.05) according to DMRT, LSD = Least Significance Difference, SEm = standard error of mean difference, CV = Coefficient of variation, EB = Early blight, LB = Late blight, PM = Powdery mildew, BLS = Bacterial leaf spot, SLS = Septorial leaf spot ** Significant at 1%.

Table 2. Effect of treatments on severity of diseases in tomato in plastic house

Treatments	Severity (%)				
	EB	LB	PM	BLS	SLS
Bio-cure B	15.66^{b}	21.66^{b}	4.67^{b}	28.75^{a}	19.33^{b}
Bavistin	11.33^{c}	18.33^{c}	2.00^{c}	28.61^{a}	16.00^{c}
Mancozeb	6.33^{d}	14.34^{d}	4.00^{b}	28.19^{a}	11.67^{d}
Control	23.33^{a}	26.66^{a}	7.67^{a}	28.33^{a}	24.33^{a}
SEm (±)	0.2887	0.333	0.833	0.605	1.518
LSD (=0.05)	0.576	0.666	1.665	1.209	3.034
Probability	<.01**	<.01**	<.01	NS	<.01**
CV (%)	2.0	1.6	12.4	2.1	8.5

Figures in the column with the same letter are not significantly different (p = 0.05) according to DMRT, LSD = Least Significance Difference, SEm = Standard Error of mean difference, CV = Coefficient of variation, EB = Early blight, LB = Late blight, PM = Powdery mildew, BLS = Bacterial leaf spot, SLS = Septorial leaf spot ** significant at 1%

Table 3. Effects of treatments in AUDPC of various tomato diseases in plastic house

Treatments	AUDPC				
	EB	LB	PM	BLS	SLS
Biocure B	721.70^{b}	1135.00^{b}	192.00^{b}	1427.10^{a}	892.02^{b}
Bavistin	524.20^{c}	967.50^{c}	83.34^{c}	1435.40^{a}	756.00^{b}
Mancozeb	273.30^{d}	722.50^{d}	165.05^{b}	1425.00^{a}	564.34^{c}
Control	1025.80^{a}	1362.50^{a}	321.25^{a}	1405.50^{a}	1119.00^{a}
SEm (±)	23.85	28.09	36.4	29.23	85.7
LSD (=0.05)	47.65	56.12	72.7	58.41	171.3
F(probability)	<.01**	<.01**	0.01**	NS	0.01**
CV (%)	3.7	2.7	12.1	2.1	10.3

Figures in the column with the same letter are not significantly different (p = 0.05) according to DMRT, LSD = Least Significance Difference, SEm = Standard Error of mean difference, CV = Coefficient of variation, EB = Early blight, LB = Late blight, PM = Powdery mildew, BLS = Bacterial leaf spot, SLS = Septorial leaf spot ** significant at 1%

EFFECT OF TREATMENTS ON YIELD OF TOMATO

Mancozeb (47.73t/ha) treated plots showed the highest yield followed by Bavistin (44.47 t/ha) and Bio-cure B (40.13 t/ha), which was significant different as compared to control (37.91 t/ha).

CONCLUSIONS

From the experiment, it is reveal that Dithane M-45 (Mancozeb,80% WP, @ 2 g/l, five times spray at seven days intervals after the appearance of the diseases) can be used to manage early blight, late blight and Septoria leaf spot in tomato in plastic house at Lamjung and similar conditions. Similarly, foliar application of Bavistin (Carbendazim 50% WP, @ 2 g/l, five times spray at seven days intervals after the appearance of the diseases) can be used to manage powdery mildew disease in tomato. Early planting might be one of the best management tools to manage the disease as powdery mildew appeared late in the season, which is an important area for future research work to find a potential measure for the best management of this disease.

ACKNOWLEDGEMENTS

We thank the World Vision International for the Technical and financial support to the completion of the research.

LITERATURE CITED

Balanchard, D. 1992. A colour atlas of tomato diseases. Wolfe Publication Limited, Book House, London. Research (Florida Tomato Committee). 298p.

Bhowmik, D., K.S. Kumar, S., Paswan and S. Srivastava. 2012. Tomato-a natural medicine and its health benefits. J. of Pharmaco. and Phytochem. 1(1): 33–43.

Chohan, S.M. 2015. Morpho - physiological studies, Management and screening of tomato germplasm against Alternaria solani, the causal agent of tomato early blight. Int. J. Agric.Biol. 17:111-118.

Choulwar, A.B. and V.V Datar.1992. Management of tomato early blight with chemicals. Maharashtra Agriculture University. 17: 214-6.

Correll, J. 2014. Powdery Mildew. *In:* J.B. Jones, T.A. Zitter, T.M. Momol and S.A. Miller (eds.), Compendium of Tomato diseases and pest. APS Press. The American Phytopathological Society.

Das M.K., S. Rajaram, C.C. Mundt and W.E. Kronstad. 1992 Inheritance of slow-rusting resistance to leaf rust in wheat. Crop Sci. 32:1452–14

FAO. 2022. FAOSTAT. https://www.fao.org/faostat/en/#data

Ghimire, N.P., M. Kandel, M. Aryal and D. Bhattarai. 2017. Assessment of tomato consumption and demand in Nepal. J. Agri and Environ. 18:83–94. https://doi.org/10.3126/aej.v18i0.19893

Gul, Z.M. Ahmed, Z. Ullah Khan, B. Khan and M. Iqbal. 2016. Evaluation of tomato lines against septoria leaf spot under field conditions and its effect on fruit yield. Agricultural Sciences.7: 181-186. doi: HYPERLINK "http://dx.doi.org/10.4236/as.2016.74018" \t "_blank" 10.4236/as.2016.74018

Krause, R.A., L.B. Massie and R. A. Hyre. 1975. Blitecast: A computerized forecast of potato late blight. Plant Disease. 59: 95-98.

Madden L., S.P. Pennypacker and Mac A. A. Nab. 1978. FAST; a Forecasting system for *Alternaria solani* on tomato. Phytopathology. 68:1354-1358.

Mayee, C.D. and V.V.Datar. 1986. Phytopathometry Technical Bulletin-1. Marathwad Agricultural University, Parabhani. 25p.

MOALD, 2020. Statistical information on Nepalese Agriculture I 2018 / 2019. Government of Nepal, Ministry of Agriculture and Livestock Development, Planning and Development Cooperation Coordination Division, Kathmandu, Nepal

NEAT, 2011. Value chain/market analysis of the off-season vegetable sub-sector in Nepal. Nepal Economic Agriculture, and Trade Activity (NEAT), United States Agency for International Development, General Development Office, Kathmandu, Nepal. 45p.

Nelson, S.C. 2008. Late blight of tomato (*Phytophthora infestans*).

Pscheidt, J.W. and W.R. Stevenson. 1986. Comparison of forecasting methods for control of potato early blight in Wisconsin. Plant Disease. 70 :915-920. ADDIN ZOTERO_BIBL {"uncited":[],"omitted":[],"custom":[]} CSL_BIBLIOGRAPHY

Rawal, R., D.M. Gautam, I.P. Gautam, , R.B. Khadka, K.M.Tripathi, P. Hanson, A.L. Acedo, W. Easdown, J.A. Hughes and J.D.H. Keatinge. 2017. Evaluation of AVRDC advanced lines of long-shelf-life tomato in the Terai region of Nepal. Acta Horticulturae. 1179:317–322. https://doi.org/10.17660/.

Saxena, K. A. 1988. Physiologic specialization in *A. solani* causing early blight of potato. Indian J. Mycol.Plant Pathol.18(2): 128-132.

Sinha, P.P. and R.K. Prasad. 1991. Evaluation of fungicides for control of early blight of tomato. Madras Agr. J. 78: 141-143.

Somers, E.A. 1966. The water content of powdery mildew conidia. Phytopathology. 56:1031-1035.