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Efficacy of Essential oil Against Early Blight (*Alternaria solani*) of Tomato (*Lycopersicon esculentum* Mill.)

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ABSTRACT: Early blight caused by *Alternaria solani* is serious disease in tomato growing areas and occur as a pre – harvest as well as post – harvest brown to black spots appears on the leaves of tomato. Thyme essential oil at different concentrations (0.5%, 0.75%, 1.0% and 1.25%) along with mancozeb were tested at 0.25% *in-vivo* during *Rabi* 2020 – 2021 for their efficacy against disease incidence, plant growth and yield parameters of tomato at the Central Research Field of the Department of Plant Pathology, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj. The results of the present investigation revealed that significantly reduced the disease incidence. Among the treatments the minimum disease intensity (%) at 75 DAT was recorded in T_3 – Thyme essential oil @ 1.0% (25.51%). The maximum plant height (cm) of tomato was significantly increased in T_3 – Thyme essential oil @ 1.0% (60.18cm) and maximum number of branches was significantly recorded in T_3 – Thyme essential oil @ 1.0% (28.00). The maximum yield (t/ha) of tomato was significantly recorded in T_3 – Thyme essential oil @ 1.0% (25.64%) as compared to untreated check (control) in T_0 – (8.740 t/ha). Higher gross return value (Rs. 2,30,400/ha), net return value (Rs. 1,71,900/ha) and B:C ratio (2.93) was found in the treatment T_3 – Thyme essential oil @ 1.0% as compared to untreated check T_0 – control (1.11).

Keywords: *Alternaria solani*, Early blight, tomato, thyme essential oil.

INTRODUCTION

Tomato (*Lycopersicon esculentum* Mill.) belongs to family Solanaceae, it is the most important tropical crop widely used throughout the world **(**Haidan *et al*., 2011). It is world's largest vegetable crop after potato and sweet potato but it ranks first in the list of canned vegetables (Anonymous, 1997). Tomato contains 95.3 percent of water, 0.07 percent calcium and niacin, all of which have great importance in metabolic activities of humans. Tomato is also popular because of its high content of vitamin A, B and C, iron and phosphorus. It also provides color and flavor to food. Moreover, tomato has got medicinal properties, the pulp and juice of fruit is digestible, promoter of gastric secretion and blood purifier. It is one of the richest vegetables which keep our stomach and intestine in good condition. Tomato seed contains 24 percent oil, which is used in canning industry. Canned and dried tomatoes are economically important processed products (Waiganjo *et al*., 2006). It is economically attractive crop because of relatively short duration and the area under cultivation is increasing day by day. The top producer of tomatoes was China (56.423.811MT) followed by India, US, Turkey, (FAOSTAT, 2019-20). Among the fungal diseases, early blight, also known as target spot, caused by *Alternaria solani*, is one of the most serious diseases. Early blight produces a wide range of symptoms at all stages of plant growth. The disease appears on leaves, stems, petioles, twig and fruits under favorable conditions resulting in defoliation, drying off of twigs and premature fruit drop (Mathur and Shekhawat, 1986).Yield losses of upto 79 percent have been reported in the U.S., of which 20 to 40 percent is due to seedling losses in the field (Jones and Grout, 1986). The most common method for controlling effectively and extensively early blight tomato disease is the use of fungicides. Though they are costly, fungicide treatments are generally the most effective control measures. However, they are not only costly but also capable of creating problems on the environment, human health in all areas of the world and may lead to the development of resistance in pathogenic fungi to common fungicides. Essential oils are completely mixture of volatile substances generally present in leaves at low concentration. Before such substances can be analyzed they have to be extracted from matrix, using dried plant material. Several methods can be employed for this purpose e.g. hydrodistillation method, steam distillation method, Soxhlet apparatus and simultaneous distillation extraction (Dung *et al.*, 1996). They appear as liquid, volatile, limpid and colored mixtures of aromatic compounds.

Essential oils are obtained from all plant parts, mainly from herbs and spices. Essential oils are environmentally safe, cost effective and easily biodegradable. This makes them useful for the management of fungal diseases in plants as alternative to synthetic fungicides. Since, tomato has an important place in vegetable, the area under tomato cultivation is increasing every year and early blight is one of the devastating disease of tomato. Therefore, keeping these points in view, the present investigation has been taken up in detail about early blight disease, the pathogen its behavior and specially on management practices.

MATERIALS AND METHODS

A. Isolation and identification of the pathogen

The leaves of tomato showing typical symptoms were collected from Central Research Field SHUATS Prayagraj, and the standard tissue isolation procedure was followed to isolate the pathogen. Diseased portion of the leaves were washed with tap water and cut under aseptic conditions into small bits and surface sterilized in sodium hypochlorite for 2 minutes. The diseased leaf bits were placed on petridish containing potato dextrose agar media. The potato dextrose agar media was prepared by peeling 200 gm of potato and boil it in 500 ml of distilled water for 15 minutes and stain through a muslin cloth. Add 20 gm of dextrose and 20 gm of agar into another 500 ml of distilled water and mix-up the volume. Then transfer the media into conical flask. The inoculated plates were incubated at room temperature (27±2°C) for 3-4 days until visible growths are seen on the plates. The fungal colonies growing in the incubated plates were sub- cultured into fresh medium until pure cultures were obtained.

B. Evaluation of thyme essential oil on different parameters in field conditions

The in *vivo* experiment was conducted at Central Research Field of Department of Plant Pathology, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj. The experiment was laid out in a randomized block design with eight treatments viz., T_0 Control, T_1 Thyme essential oil @ 0.5%, T_2 Thyme essential oil @ 0.75%, T_3 Thyme essential oil @ 1.0%, T_4 Thyme essential oil @ 1.25%, T_5 Mancozeb @ 0.25% were evaluated against disease intensity of early blight of tomato. The application of thyme essential oil and Mancozeb was done after the appearance of disease at 30 DAT followed by sprayings at 15 days interval. The observations were recorded before each spray and the disease intensity was calculated by using the disease rating scale given by (Mayee and Datar, 1986).

Number of effected Leaves (no.) for calculating PDI by using this diseases coring chart.

Grade	Leafarea covered	Reaction
0	Number symptoms of disease on leaves.	Immune
1	Small spots covering 1% or less leaf area	Highly resistant
3	Spots small (upto 5 mm in size) covering 1-10%of Leaf area.	Resistant
5	Spots enlarging covering 11-25% of leaf area.	Moderately resistant
7	Spots coalesce to form big patches covering 26-50% of leaf area	Moderately susceptible
9	Big spots covering 51% or more of leaf area	Highly susceptible

Disease intensity (%) is calculated by using the following formula given by Wheeler, (1969):

Disease intensity (%) =

$$\frac{\text{Sum of all disease rating}}{\text{Total no. of rating} \times \text{Max. disease grade}} \times 100$$

Effect of thyme essential oil on different parameters of tomato

Pre harvest and post-harvest observations were recorded -

Pre harvest observations: Recorded at 30, 45, 60 and 75 DAT.

— Disease intensity (%); — Plant height (cm); — Number of branches

Post-harvest observation:

— Yield (t/ha)

RESULTS AND DISCUSSION

Thyme essential oil

Effect of thyme essential oil on disease intensity (%).

The efficacy of Thyme essential oil as foliar spray against early blight disease incidence of tomato was evaluated under field conditions. Data in Table 1 clearly demonstrate that all the treatments were significantly reduced the disease incidence. The minimum disease intensity (%) was recorded in T_3- Thyme essential oil @ 1.0% (25.51%), followed by T_2 –Thyme essential oil @ 0.75% (26.20%), T_4- Thyme essential oil @ 1.25% (26.29%), T_1- Thyme essential oil @ 0.5% (28.54%), as compared to treated T_5– Mancozeb @ 0.25% (24.47%) and untreated control T_0 - control (36.55%).

Among the treatments, (T_5, T_3 and T_2) and (T_3, T_2 and T_4) were found non – significant to each other. This may have happened because of the presence of phenolic compounds such as thymol as a main constituent in thyme essential oil, which might have disrupted the fungal cell membrane resulting in minimum percent disease intensity. Similar findings have been reported by Nehal *et al*., (2009); Seham and Ghoneem (2014); El-Awady *et al*., (2016).

Table 1: Effect of different concentrations of thyme essential oil on disease intensity (%) of early blight of tomato at 30, 45, 60 and 75 DAT.

Sr. No.	Treatments	Dosage	30 DAT Before spray	45 DAT After 1st spray	60 DAT After 2nd spray	75 DAT	Avg. PDI
T_0	Control (Untreated check)	—	21.36	27.59	35.92	36.55	30.35
T_1	Thyme essential oil (FS)	0.5%	19.89	24.66	27.34	28.54	25.10
T_2	Thyme essential oil (FS)	0.75%	19.11	23.53	25.82	26.20	23.66
T_3	Thyme essential oil(FS)	1.0%	18.70	21.44	24.92	25.51	22.64
T_4	Thyme essential oil (FS)	1.25%	19.42	23.49	26.27	26.29	23.86
T_5	Mancozeb (Treated check) (FS)	0.25%	19.55	21.01	21.23	24.47	21.56
F Test			S	S	S	S	
SEd±			0.34	0.50	0.89	0.32	
CD (5%)			1.09	1.97	2.86	1.05	

Effect of thyme essential oil on plant height (cm). The plant height of tomato significantly increased as in Table 2. in treatment T_3–Thyme essential oil @ 1.0% (60.18 cm), followed by, T_2– Thyme essential oil @ 0.75% (58.12cm), T_4–Thyme essential oil @ 1.25% (56.70cm), T_1– Thyme essential oil @ 0.5% (55.90cm), as compared to treated T_5– Mancozeb @ 0.25% (58.04cm) and untreated control T_0 – Control (45.71cm).Among the treatments, (T_1, T_4 and T_5) and (T_4, T_5 and T_2) were found non – significant to each other. This may have happened because of the presence of phenolic compounds such as thymol as a main constituent in thyme essential oil, which might have disrupted the fungal cell membrane resulting in minimum percent disease intensity which results in growth of the plant. Similar findings have been reported by Nehal *et al*., (2009); Seham and Ghoneem (2014).

Effect of thyme essential oil on number of branches. The number of branches of tomato significantly increase as in Table 2 in T_3–Thyme essential oil @ 1.0% (28.00), followed by, T_2– Thyme essential oil @ 0.75% (26.40), T_4–Thyme essential oil @ 1.25% (24.53), T_1– Thyme essential oil @ 0.5% (23.46), as compared to treatedT_5– Mancozeb @ 0.25% (26.06) and untreated controlT_0 - Control (16.80).Among the treatments, (T_1 and T_4) and (T_5 and T_2) were found non – significant to each other, This may have happened because of the presence of phenolic compounds such as thymol as a main constituent in thyme essential oil, which might have disrupted the fungal cell membrane resulting in increase in number of branches significantly increase in plant growth. Similar findings have been reported by Nehal *et al*., (2009); Seham and Ghoneem (2014).

Effect of thyme essential oil on yield of tomato (t/ha). Results revealed that the maximum yield (t/ha) of tomato significantly increased as in Table 2. in T_3-Thyme essential oil @ 1.0% (25.64t/ha) followed by T_2-Thym essential oil @ 0.75% (21.06t/ha),T_4-Thyme essential oil@ 1.25% (17.66t/ha), T_1- Thyme essential oil @ 0.5% (16.95t/ha) as compared to treated T_5-Mancozeb @ 0.25% (24.79t/ha) and untreated control T_0- Control (8.740 t/ha). Among the treatments, (T_1 and T_4) and (T_5 and T_3) were found non – significant to each other.

The harvested yield, in all the treatments, were significantly higher than the controlled and amounted to 4.4 – 43.3% and 23.8 – 49.1% in the two cultivation seasons. Highly effected treatments induce the obvious increase of yield being for 1% thyme essential oil 22.1% and 40% in 2006 and 2007 cultivation seasons, respectively. The lowest increase in yield 4.4 and 23.8 was observed for fungicide treatment. Similar findings have been reported by Nehal *et al.*, (2009); Seham and Ghoneem (2014).

Table 2: Effect of different concentrations of thyme essential oil on plant height (cm), number of branches and yield of tomato (t/hac) at 30, 45, 60 and 75 DAT.

Sr. No.	Treatments	Dosage	Plant Height (cm)	Number of Branches	Yield (t/ha)
T_0	Control (Untreated check)	-	45.71	16.80	8.740
T_1	Thyme essential oil (FS)	0.5%	55.90	23.46	16.95
T_2	Thyme essential oil (FS)	0.75%	58.12	26.40	21.06
T_3	Thyme essential oil (FS)	1.0%	60.18	28.00	25.4
T_4	Thyme essential oil (FS)	1.25%	56.70	24.53	17.66
T_5	Mancozeb (Treated check) (FS)	0.25%	58.04	26.06	24.79
F Test			S	S	S
SEd±			0.58	0.40	0.38
CD (5%)			1.56	1.28	1.23

CONCLUSION

The *in-vivo* studies revealed that minimum disease intensity (%) of tomato crop at 30, 45, 60 and 75 DAT, the maximum plant height, number of branches and maximum total yield (t/ha) were recorded in treatment T_3 – Thyme essential oil @ 1.0%. The findings of the present experiment are limited to one crop season (December 2020 to March 2021) under Prayagraj Agro-climatic conditions, as such to validate present findings more such trials should be carried out in future. As application of essential oil is applicable, safe and cost effective method for controlling such foliar diseases. Also, the use of essential oils in agriculture could be a suitable alternative for inclusion in disease control systems and do not leave a toxic residue in the product.

FUTURE SCOPE

Further scope for experiment can be carried as to check the significantly decrease in disease intensity and thus increase in plant height, number of branches and yield of tomato by using thyme essential oil at different concentrations.

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Conflict of Interest. None.

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