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# The efficacy of various fungicides against the tomato early blight (*Alternaria solani*)

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**ABSTRACT**

The tomato is one of the most popular vegetables farmed worldwide. One of the most harmful tomato diseases is early blight, which is a disease that the fungus *Alternaria solani* causes.This will reduce the quality and quantity of tomatoes. Nearly 80% losses were reported due to this disease. To evaluate the fungi-toxic activity of the fungicides Kavach, Cbrio Top, Merivon, Avtar, Amistar, and Tilt at the plant pathology department of the faculty of agriculture at LPU, Punjab, over the years 2021–2022, the poisoned food approach was adopted. Six different fungicides were checked at different concentration like 50, 100, 150 ppm at lab condition. Propiconazole (Tilt) was found to be most effective, i.e. percent inhibition was 100%. Same fungicides were checked at field.Among this fungicides Cbrio Top, Merivon, Amistar were found to be most effective followed by kavach, Tilt and Avtar.

***Key words:*** *Tomato, Early blight, Alternaria solani, Percent Disease Index, Poisoned Food technique, Fungicide*

## Introduction

The most common vegetable in the world is *Lycopersicon esculentum* Mill (tomato) of the Solanaceae family. The word tomato is derived from the Aztec word Tomatl, which is spoken in South America. In India 2018-19, tomato was cultivated in 781 thousand ha area and its production is 190.07 Lakh tonnes. Madhya Pradesh is India's biggest tomato producer, contributing for 13.79 percent of total tomato production. Andhra Pradesh ranks second with a contribution of 13.72 percent, while Karnataka ranks third with a contribution of 8.77 percent to national production in 2018-19 (Indian horticulture database 2020). In a number of places, tomatoes are attacked by a range of illnesses produced by virus, bacteria, fungi, nematodes, and other organisms (Mark *et al.*, 2006). The most prevalent and effective disease affecting the tomato crop overall is early blight. One of the most serious and prevalent fungal diseases in the United States and across the world is early blight, which is a disease that the fungus *Alternaria solani* causes (Jones *et al.*, 1991).

During the *Rabi* and *Kharif* seasons, the pathogen can damage all parts of the crop, such as the leaf, stem, and fruit, as well as all stages of crop growth. Up to 79 percent of output losses have been attributed to this disease in numerous countries, including Nigeria, India, Canada, and the United States (Praveen, 2019; Sherf and MacNab, 1986; Datar and Mayee, 1981; Gwary and Nahunnaro, 1998 and Basu, 1974b). The ideal temperature for fungal development was 23! to 28!, with 6 to 8 pH according to Yunhui *et al.* (1994). Ellis and Gibson (1975) and Neergaard (1945) found that the pathogen's mycelium are septate, branched and hyaline and its letters darken in colour. There is no sexual reproduction or sexual spore that can germinate. It has single conidia which germinate by simple conidiophores. *A. solani* is a large-spored fungus that also has both septation horizontal and vertical. The conidia of *A. solani* are dark muriform, olivaceous brown or Pale golden and in broadest part long (150-300 µm) and thick(15-19 µm) with 0-3 longitudinal septa and 5-10 transverse septa; 2.5-5 µm thick, sometimes branching, declining gradually according to Ellis (1971). (Jones and Grout, 1986) *Alternaria solani*is a pathogen from the phylum: Ascomycota, Deuteromycetes: class, Moniliales: order, Dematiaceae: family.

Walker (1952) the spots were 0.3-0.4 cm in diameter, angular or spherical in shape, and encircled by a thin chlorotic zone. Symptoms progressed from the lower to the top leaves. Small brown areas on lower leaves are the first signs of leaf spots. Concentric bands of elevated and depressed brown tissue were visible as the spots matured. Defoliation is common in heavily diseased plants. Chaerani *et al.* (2006) scrutinised that on the stem-end of the fruit, the infection results in dark, sunken, leathery, and purple lesions. These lesions become large and penetrate the fruit's flesh. Fruits that have been infected tend to drop prematurely, and those that do reach maturity lose their marketability. A concentric ring formed on the location where the fruit's stalk and fruit meet.A number of approaches have been explored to treat crop diseases, with fungicides proving to be more efficient than botanicals or biocontrol agents in reducing pathogen spread. Copper oxychloride, carbendazim, mancozeb, and other fungicides are extensively used in India, and their efficacy has been researched by several groups (Lewis and Miller (2003), Kumara *et al.*(2010)).

This study's main objective was to compare the *In-vitro* and *In-vivo* performance of various fungicides against tomato early blight at various doses. The fungicides known by trade names kavach (Chlorothalonil 75 percent WP), Cbrio Top (Metiram 55 percent + Pyraclostrobin 5 percent WG), Merivon (Fluxapyroxad 21.26 percent + Pyraclostrobin 21.26 percent SC), Avtar (Zineb 68 percent + Hexaconazole 4 percent WP), Amistar (Azoxystrobin 23 percent SC) and Tilt (Propiconazole 25 percent EC) were commonly used to control early blight diseases of tomato crops at Lovely Professional University in Paghawara, Punjab during the years 2021-2022.

## Materials and Methods

### *In-vitro* analysis of several fungicides against the tomato early blight

The effectiveness of fungicides at three concentrations against *Alternaria solani* was examined using the poisoned food approach (Falck, 1907). According to the treatment requirements, fungicides were administered to the PDA medium before sterilisation. The centre of a petri plate was put with a 5mm disc from the *Alternaria Solani* culture that was seven days old. The diameter of the *Alternaria Solani* colony was used to assess the fungicide activity in each treatment and compare it to the control.In this experiment, six fungicide (Chlorothalonil 75% WP, Metiram 55% + Pyraclostrobin 5% WG, Fluxapyroxad 21.26% + Pyraclostrobin 21.26% SC, Zineb 68% + Hexaconazole 4% WP, Azoxystrobin 23 % SC and Propiconazole 25% EC) were tested for effectiveness at three different concentrations, 50, 100, and 150 ppm.

The percent suppression of fungal mycelium growth was estimated using Vincent's method (1927).

$$I = \frac{C - T}{C} \times 100$$

Where,
I = Inhibition percentage
C = Controlled radial growth
T = Treated radial growth.

### *In-vivo* analysis of several fungicides against the tomato early blight

During Rabi 2021–2022, field tests on the effectiveness of fungicides were done at Lovely Professional University. With seven treatments and three replications, the experiment was created using the Randomized Block Design method.Laksh tomato variety was used for experiment. The fungicides and it's dose was Chlorothalonil 75% WP @ 2g, Metiram 55% + Pyraclostrobin 5% WG @ 2 g, Fluxapyroxad 21.26% + Pyraclostrobin 21.26% SC @ 0.4ml, Zineb 68% + Hexaconazole 4% WP @2.5 g, Azoxystrobin 23 % SC @ 1ml and Propiconazole 25% EC @ 1ml. The first spray was applied when the primary symptoms of early blight was observed in the field, and the second and third sprays were applied 15 days later. Data on disease severity was collected before the first spray, 15 days after the all three

**Table 1.** Early blight disease rating scale description (Pandey *et al.*, 2003)

| Scale | Infection Percentage | Description |
|---|---|---|
| 0 | 0% | Free of infection |
| 1 | 1-10% | A few lower leaves with one or two necrotic patches |
| 2 | 11-25% | A few isolated spots on leaves |
| 3 | 26-50% | Many spots coalesced on the leaves |
| 4 | 51-75% | On the stem petiole, fruit, and leaf area, irregular, blighted leaves and a sunken lesion with observable concentric rings were present. |
| 5 | More than 75% | Completely blighted plants, with leaves and fruits starting to fall |

sprays. A disease severity rating scale from 0 to 5 was used to assess the early blight's severity (Pandey *et al.*, 2003) on 10 plants chosen at random in each replication of the treatment.

Wheeler's(1969) approach was used to generate the Percent Disease Index (PDI).

$$PDI = \frac{\text{Sum of individual disease ratings}}{\text{Total number of plants inspected} \times \text{Maximum Number of disease rating}} \times 100$$

## Results and Discussion

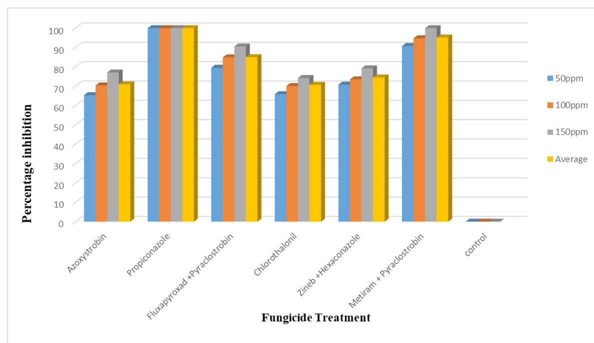
### *In-vitro* analysis of several fungicides against the tomato early blight

According to the observations, all six fungicides tested at concentrations of 50 ppm, 100 ppm, and 150 ppm prevented this pathogen's mycelial development. Control did not prevent the pathogen's mycelial development. *Alternaria solani*'s mycelial growth is inhibited when fungicide concentration rises, which results in a reduction in *A. solani* growth.

Due to their ability to decrease *Alternaria solani* mycelial growth compared to the control, all of the fungicides were therefore proven to be fungistatic against the pathogen. In order of merit, these fungicides were Propiconazole 25% EC, Metiram 55% + Pyraclostrobin 5% WG, Fluxapyroxad 21.26% + Pyraclostrobin 21.26% SC, Zineb 68% + Hexaconazole 4% WP, Azoxystrobin 23% SC and Chlorothlonil 75% WP.

The fungicides Propiconazole 25% EC (100%) and Metiram 55% + Pyraclostrobin 5% WG (95.18%) were more effective, Fluxapyroxad 21.26% + Pyraclostrobin 21.26% SC (84.99%) and Zineb 68% + Hexaconazole 4% WP (74.52%) were moderate effective and Azoxystrobin 23% SC (70.97%) and Chlorothlonil 75% WP (70.7%) were less effective.

However, mycelial growth of all the six fungicides were also recorded at 50 ppm, 100 ppm and 150 ppm. It was observed that the Least average mycelial growth were observed in Propiconazole 25% EC, i.e. 00 mm followed by Metiram 55% + Pyraclostrobin 5% WG, i.e. 4.3 mm, Fluxapyroxad 21.26% + Pyraclostrobin 21.26% SC, i.e. 13.5 mm, Zineb 68% + Hexaconazole 4% WP, i.e. 22.9 mm, Chlorothlonil 75% WP, i.e. 26.9 mm and Azoxystrobin 23% SC, i.e. 27 mm (Table 4). Fungicides were used to determine their efficacy under Similar fungistatic results were also observed by Singh *et al.* (2018) and Roy *et al.*(2019), they discovered that *Alternaria solani*'s mycelial development is




**Graph 1.** *In-vitro* analysis of several fungicides against *Alternaria solani* by Poisoned Food Technique

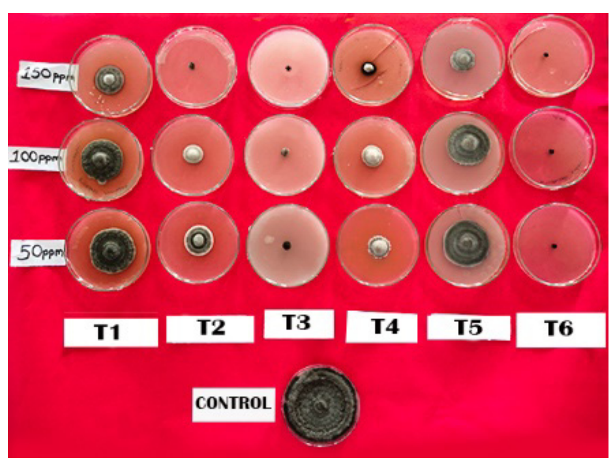



**Fig. 1.** *In-vitro* analysis of several fungicides against *Alternaria solani* by Poisoned Food Technique

most effectively inhibited by propiconazole 25 % EC. Mahantesh *et al.*, (2017), Vanama and Ram (2021) and Vijayalakshmi G *et al.* (2018) they also observed that Azoxystrobin 23% SC is moderately effective.

### *In-vivo* analysis of several fungicides against the tomato early blight

Situation on the field data on the percentage disease index (PDI) were collected at 15-day intervals following spraying. All of the fungicides were shown to be substantially more effective than the control in terms of disease reduction. Metiram 55% + Pyraclostrobin 5% WG was found more significant according to average, i.e. 17.17% and control was 30.5% followed by Azoxystrobin 23% SC, i.e. 17.95%, Fluxapyroxad 21.26% + Pyraclostrobin 21.26% SC i.e. 17.97%, Chlorothlonil 75%, WP, i.e. 20.7%, Propiconazole 25% EC, i.e. 20.95% and Zineb 68% + Hexaconazole 4% WP, i.e. 22.7%. Metiram 55% + Pyraclostrobin 5% WG, Azoxystrobin 23% SC and Fluxapyroxad 21.26% + Pyraclostrobin 21.26% SC were more effective over control than other three, i.e. Chlorothlonil 75% WP, Propiconazole 25% EC and Zineb 68% + Hexaconazole 4% WP. Similar kind of result observed by Amrita Saxena *et al.* (2016) and Sharma *et al.* (2020) they conclude that Azoxystrobin 23% SC and Metiram 55% + Pyraclostrobin 5% WG give highest efficacy against *Alternaria solani*. Sharma *et al.* (2018), and Vanama

**Table 2.** *In-vitro* analysis of several fungicides against *Alternaria solani* by Poison Food Technique

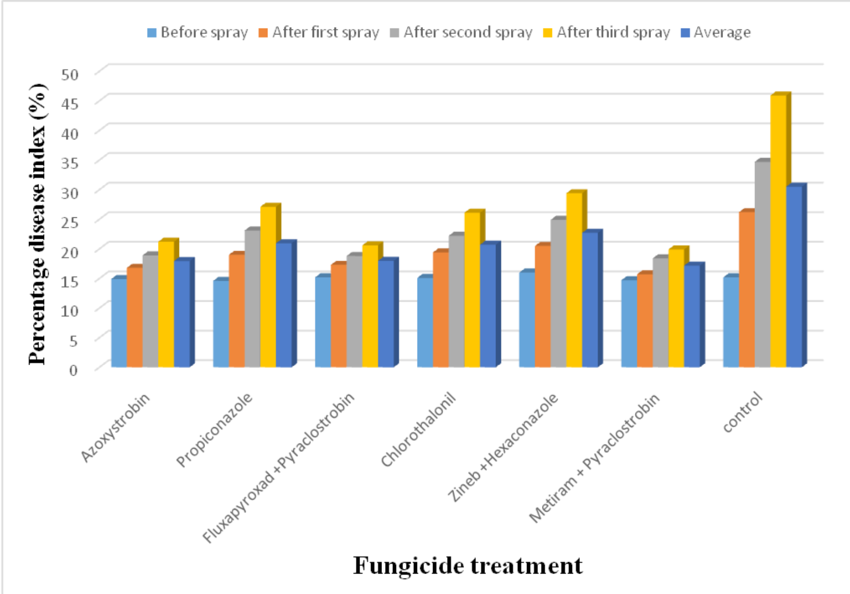
| Treat-ment No. | Treatment | Colony diameter (mm)* | | | Mean | Percent Inhibition* | | | Average Percent Inhibition |
|---|---|---|---|---|---|---|---|---|---|
| | | 50 ppm | 100 ppm | 150 ppm | | 50 ppm | 100 ppm | 150 ppm | |
| T1 | Azoxystrobin 23% SC | 30.8 | 24.4 | 26 | 27 | 65.4 | 70.4 | 77.11 | 70.97 |
| T2 | Propiconazole 25% EC | 0 | 0 | 0 | 0 | 100 | 100 | 100 | 100 |
| T3 | Fluxapyroxad 21.26% + Pyraclostrobin 21.26% SC | 18.4 | 13.6 | 8.5 | 13.5 | 79.55 | 84.88 | 90.55 | 84.99 |
| T4 | Chlorothalonil 75% WP | 30.7 | 26.9 | 23.2 | 26.9 | 65.88 | 70.11 | 74.22 | 70.7 |
| T5 | Zineb 68% + Hexaconazole 4% WP | 26.2 | 23.8 | 18.7 | 22.9 | 70.8 | 73.55 | 79.22 | 74.52 |
| T6 | Metiram 55% + Pyraclostrobin 5% WG | 8.3 | 4.7 | 0 | 4.3 | 90.77 | 94.77 | 100 | 95.18 |
| T7 | Control | 90 | 90 | 90 | 90 | 0 | 0 | 0 | 0 |
| | C.D. | | 0.743 | 1.17 | 1.029 | | 0.84 | 1.299 | 1.141 |
| | SE(m) | | 0.243 | 0.382 | 0.336 | | 0.274 | 0.424 | 0.372 |
| | SE(d) | | 0.343 | 0.54 | 0.475 | | 0.388 | 0.6 | 0.527 |
| | C.V. | | 1.437 | 2.492 | 2.528 | | 0.703 | 1.042 | 0.867 |

*= Mean of three replications

**Table 3.** *In-vivo* analysis of several fungicide on Percentage disease index tomato early blight

| Treat-ment No. | Treatment | Mean of Percentage disease Index (%) | | | | |
|---|---|---|---|---|---|---|
| | | Before spray | After first spray | After second spray | After third spray | Average |
| T1 | Azoxystrobin 23% SC | 14.9 (22.70)* | 16.8 (24.19) | 18.9 (25.76) | 21.2 (27.41) | 17.95 (25.06) |
| T2 | Propiconazole 25% EC | 14.6 (22.46) | 19 (25.84) | 23.1 (28.72) | 27.1 (31.37) | 20.95 (27.23) |
| T3 | Fluxapyroxad 21.26% + Pyraclostrobin 21.26% SC | 15.2 (22.94) | 17.3 (24.57) | 18.8 (25.69) | 20.6 (26.99) | 17.97 (25.08) |
| T4 | Chlorothalonil 75% WP | 15.1 (22.86) | 19.4 (26.13) | 22.2 (28.11) | 26.1 (30.72) | 20.7 (27.06) |
| T5 | Zineb 68% + Hexaconazole 4% WP | 16 (23.57) | 20.5 (26.92) | 24.9 (29.93) | 29.4 (32.83) | 22.7 (28.45) |
| T6 | Metiram 55% + Pyraclostrobin 5% WG | 14.7 (22.54) | 15.7 (23.34) | 18.4 (25.40) | 19.9 (26.49) | 17.17 (24.47) |
| T7 | Control | 15.2 (22.94) | 26.2 (30.78) | 34.7 (36.09) | 45.9 (42.64) | 30.5 (33.52) |
| | C.D. | 5.626 | | | | |
| | SE(m) | 1.879 | | | | |
| | SE(d) | 2.658 | | | | |
| | C.V. | 17.897 | | | | |

*Arc sine converted values are shown in parentheses.




**Graph 2.** *In-vivo* analysis of several fungicide on Percentage disease index tomato early blight

and Ram (2021) and Nagesh *et al.* 2019 they also reported similar kind of effectiveness of fungicide against *Alternaria solani*.

## Conclusion

In this study we concluded that in *In-vitro* condition Tilt fungicide gave best effective against mycelium growth of *Alternaria solani*. And in *In-vivo* condition Cabrio Top, Merivon and Amistar fungicides gave best effective against *Alternaria solani*.

## References

Amrita Saxena, Birinchi Kumar Sarma and Harikesh Bahadur Singh, (Apr–June 2016). Effect of Azoxystrobin Based Fungicides in Management of Chilli and Tomato Diseases. *Proc. Natl. Acad. Sci., India, Sect. B Biol. Sci.* 86(2) : 283–289 DOI 10.1007s40011-014-0422-8.

Basu, P.K. 1974b. Measuring early blight, its progress and influence on fruit losses in nine tomato cultivars. *Can Plant Dis Surv.* 54: 45-51.

Chaerani, R. and Voorrips, R. E. 2006. Tomato early blight (*Alternaria solani*): The pathogen, genetics, and breeding for resistance. *Journal of General Plant Pathology* 2005; 72(6):335-347. https://doi.org/10.1007/s10327-006-0299-3

Datar, V. V. and Mayee, C. D. 1981. Assessment of loss in tomato yield due to early blight. *Indian Phytopathology*, 3: 191-195.

Ellis, M.B. 1971. Dematiaceous hyphomycetes. Commonwelth Mycological Institute, Kew, Surry, England, pp 608.

Ellis, M.B. and Gibson, I.A.S. 1975. *Alternaria solani* no. 45 set 48. Commonwealth Mycological Institute, Kew, Surrey, UK.

Falck, R. 1907. Wachtumgesetze, wachstum Laktorehnund temperature wertder holzersterenden. *Myceture.* 32: 38-39

Gwary, D.M. and Nahunnaro, H. 1998. Epiphytotics of early blight of tomatoes in North-eastern Nigeria. *Crop Prot*. 17 : 619-624.

Jones, J.B., Jones, J.P., Stall, R.E. and Zitter, T.A. 1991. Infectious antifungal. *Plant Physiology*. 108 : 17-27.

Jones, L.R. and Grout, 1986. *Alternaria solani* (Ellis & G. Martin). *Annual Report of the Vermont Agricultural Experimental Station.* 9 : 86.

Kumara, A., Kulkarni, K.T., Thammaiah, M.S., Hegde, N. 2010. Fungicidal management of early blight of tomato. *Indian Phyto Pathol* 63(1): 96–97.

Lewis, I.M.L. and Miller, S.A. 2003. Evaluation of fungicides and abiocontrol agents for the control of anthracnose on green pepper fruit. Nematicide Test Report [Online]. *New Fungicide and Nematicide Data Committee of the American Phytopathological Society*. 58:62. doi: 10.1094/FN58.

Mahantesh, S.B., Karegowda, C., Kavitha, S.V., Kavita, T.H. and Punith, N.D. 2017. *In-vitro* evaluation of fungicides, bio agents and natural plant extracts against early blight caused by *A. Solani*. *IJCS*. 5(5) : 1346-50.

Mark, L. Gleason and Brooke, A. Edmunds. 2006. Tomato diseases and disorders. *Physiological Disorder*, 12pp.

Nagesh, S.K., Mushrif, T.B., Manjunatha Reddy, C.G. Sangeetha and JS Aravinda Kumar, 2019. Fungicides for the Management of Early Blight of Tomato Caused by *Alternaria solani*, *Mycol Pl Pathol*. 49(3): 308-313.

Neergaard, P. 1945. *Danish species of Alternaria and Stemphylium: taxonomy, parasitism, economic significance.* Oxford University Press, London, 260–287 pp.

Pandey, K.K., Pandey, P.K., Kallo, G. and Banerjee, M.K. 2003. Resistance to early blight of tomato with respect to various parameters of disease epidemics. *J Gen Plant Pathol*. 69 : 364-371.

Praveen, K.M. 2019. Survey and Screening of Tomato Varieties against Early Blight (*Alternaria solani*) Under Field Condition. *International Journal of Pure & Applied Bioscience*. 7(2) : 629-635. https://doi.org/10.18782/2320-7051.7631

Roy, C.K., Akter, N., Sarkar, M.K., Pk, M.U., Begum, N., Zenat, E.A. and Jahan, M.A. 2019. Control of Early Blight of Tomato Caused by and Screening of Tomato Varieties against the Pathogen. *The Open Microbiology Journal*. 13(1).

Sharma, R.K., Patel, D.R., Chaudhari, D.R., Kumar V. and Patel, M.M. 2018. Effect of Some Fungicides against Early Blight of Tomato *(Lycopersicon esculentum Mill.)* Caused by *Alternaria solani* (Ell. and Mart.) Jones and Grout and their Impact on Yield. *International Journal of Current Microbiology and Applied Sciences* 7(07) : 1395-1401.

Sharma. R. K., J. K. Patel, D. R. Patel and Patel. R. N. 2020. Management of Early Blight of Potato (*Solanum tuberosum* L.) caused by *Alternaria solani* [(Ellis & Martin) Jones and Grout] through Fungicides and its Impact on Yield. *Int. J. Curr. Microbiol. App. Sci.* 9(03): 1683-1693. doi: https://doi.org/10.20546/ijcmas.2020.903.196

Sherf, A. F. and MacNab, A. A. 1986. *Vegetable Diseases and Their Control.* John Wiley and Sons: New York, NY, USA, p. 728.

Singh, Vaibhav Pratap, Khan, R.U. and Pathak, Devesh 2018. *In-vitro* evaluation of fungicides, biocontrol agents and plant extracts against early blight of tomato caused by *Alternaria solani* (Ellis and Martin) Jones and Grout. *Internat. J. Plant Protec*. 11(1): 102-108, DOI: 10.15740/HAS/IJPP/11.1/102-108.

Vanama Sowmya and Ram Chandra, 2021. *In-vitro* and *In-vivo* efficacy of chemical fungicides against early blight of tomato (*Solanum lycopersicum L.*) incited by *Alternaria solani* (Ell. & Mart). *Journal of Pharmacognosy and Phytochemistry*. 10(1) : 833-837.

Vijayalakshmi, G., K. Karuna and Mahadevaswamy, G. 2018. Evaluation of Microbial Biocontrol Agents and Fungicides against *Alternaria helianthi* Causing Leaf Blight of Sunflower. *Int. J. Curr. Microbiol. App. Sci*. 7 (01) : 2726-2730. doi: https://doi.org/10.20546/ijcmas.2018.701.326

Vincent, J. M. 1927. Distortion of fungal hyphae in presence of certain inhibitors. *Nature*. 159 : 850.

Walker, J.C. 1952. *Diseases of Vegetable Crops,* 1st ed. MacGraw-Hill Book Company, Inc. New York. Pp. 471-474.

Wheeler, B.E.J. 1969. *An Introduction of Plant Diseases*. John Willey and Sons Ltd. London. pp. 301.

Yunhui, T., Jinong, L. and Jingyou, X. 1994. A study on the biology and pathogenicity of *Alternaria solani* on tomato. *Journal of Jiangsu Agricultural College*. 15(3): 29-31.