International Journal of Environment, Agriculture and Biotechnology
Vol-9, Issue-4; Jul-Aug, 2024
Peer-Reviewed International Journal
Journal Home Page Available: https://ijeab.com/
Journal DOI: 10.22161/ijeab

Sustainable Management of Tomato Early Blight with Plant Extracts

Abarna R*, Jinisha Blessie J.P

Agricultural College and Research Institute, Vazhavachanur, Tamil Nadu, India
*abarnaravichandran03@gmail.com

Received: 03 Jun 2024; Received in revised form: 08 Jul 2024; Accepted: 14 Jul 2024; Available online: 21 Jul 2024

Abstract— *This study focused on developing eco-friendly management strategies for early blight disease in tomatoes, caused by Alternaria solani, through the use of botanical extracts from eight plants: Neem, Prosopis, Nerium, Senna, Lantana, Pungam, Coconut, and Calotropis. The research was carried out at the Agricultural College and Research Institute in Vazavachanur, Thiruvannamalai, to assess these botanicals in vitro and in vivo effectiveness against the pathogen. In laboratory conditions, the extracts were tested at a 10% concentration, and their ability to inhibit the pathogen's mycelial growth was evaluated. Neem leaf cold extract exhibited the highest inhibition at 77.8%, followed by Nerium at 75.9%, while Senna showed limited effectiveness. In a field trial using the PKM-1 tomato variety, the lowest disease index was observed with neem leaf extract spraying (28%) and Nerium extract (30.2%), indicating their potential as effective alternatives for managing early blight.*

Keywords— *Tomato, Alternaria solani, Botanicals, Early blight management, Inhibition*

I. INTRODUCTION

Tomato (*Solanum lycopersicum*), originally from the Andean region of South America, ranks among the most widely grown horticultural crops worldwide, flourishing in climates ranging from tropical to temperate zones (Knapp and Peralta, 2016). Its hardiness enables it to endure adverse outdoor temperatures. As the second most consumed vegetable globally after potatoes, tomato production is notable, with India producing 22,337 million metric tonnes from 801 thousand hectares (Cammarano *et al*., 2022). In Tamil Nadu alone, tomatoes are cultivated on 38.78 thousand hectares, yielding 840.21 million tonnes, constituting 8.1% of India's total tomato production (NHB, 2018).

Tomatoes are consumed in various forms: fresh, in many culinary dishes, or processed into products such as sauce, ketchup, juice, salsa, paste, soup, and pickles. They are rich in vitamins A and C, and the antioxidant lycopene, which offers health benefits, including protection against cancer and heart diseases. The rising demand for both fresh and processed tomatoes underscores the need for increased production (Kaur *et al.*, 2004).

Despite their significance, tomato plants in India are susceptible to over 20 diseases. Early blight, caused by *Alternaria solani* poses a major global threat to tomato crops (Adhikari and Panthee, 2017). This disease is prevalent across India, leading to significant yield losses, with reductions of up to 63% reported in some cases (Christ Maczuga, 1989). Although *Alternaria solani* reproduces asexually, highly virulent isolates can overcome existing resistance genes (Meena *et al*., 2017). This study explores the effectiveness of various botanicals, both in vitro and in vivo, as potential control measures against early blight caused by *A. solani*, and identifies the biologically active components of the most effective plant extract against the pathogen.

II. MATERIALS AND METHODS

Isolation of *Alternaria solani* from infected leaves

Infected leaf samples were collected from tomatoes grown at AC&RI, Vazhavachanur. The diseased sections were cut into small pieces and surface-sterilized with a 0.1%

mercuric chloride solution for one minute, followed by multiple rinses with sterile distilled water.

The sterilized pieces were placed on Potato Dextrose Agar (PDA) medium with 50 ppm streptomycin sulfate in sterile Petri dishes and incubated at 28±2°C for 48-72 hours. The mycelium that emerged from the pieces was aseptically transferred to Potato Dextrose Agar slants. The fungus was then purified using the single hyphal tip method (Ainsworth, 1981), and the stock culture was maintained on slants.

Pathogenicity test of the isolate

A seven-day-old culture of *Alternaria solani*, grown in three test tubes containing 5 ml of potato dextrose agar medium, was harvested and transferred into a blender with 250 ml of sterile water. The blender was run through cycles of high and low speeds for 3-4 minutes, vigorously slicing and beating the fungal mats. The mixture was then centrifuged intensely, reducing the fungal mats into small particles suitable for passage through the fine spray nozzle of an atomizer. The resulting mycelial suspension demonstrated high efficacy in mass inoculation experiments, effectively inducing disease outbreaks under field conditions.

Tomato plants aged between 60 and 70 days were selected for inoculation. These plants were exposed to a humid environment for 24 hours by covering them with polyethylene bags. Before inoculation, the plants were surface sterilized with 0.1% mercuric chloride and rinsed with sterile water. The mycelial suspension was sprayed onto the leaves early in the morning. As a control, other plants were sprayed with an equal volume of sterile distilled water. All plants were immediately covered with polyethylene bags containing water droplets and kept in this state for 48 hours. Regular observations were made to monitor the progression of disease development.

Disease development and re-isolation of the isolate

Seven days after inoculation, the leaves were examined for disease progression. The pathogen was re-cultured from the affected areas, and the new cultures were compared and validated against the original isolate.

In this study, eight botanical extracts were tested as treatments: T0 - Control; T1 - Neem; T2 - Prosopis; T3 - Nerium; T4 - Senna; T5 - Lantana; T6 - Pungam; T7 - Coconut; T8 - Calotropis (refer to Table 1). These botanicals were examined for their inhibitory effects on the pathogen under laboratory conditions. They were applied at a 10% concentration, with a control group without botanicals for comparison. The impact of these treatments on the linear growth of the pathogen was carefully monitored.

To evaluate their effects on the radial growth of the fungus, the botanicals were added to 20 ml of sterilized Potato Dextrose Agar medium in 100 ml conical flasks. After cooling, the medium was poured into sterile petri dishes. These plates were inoculated with 8 mm discs of the pathogen and incubated for 10 days at room temperature (28±2°C). Concurrently, a set of plates containing the medium without the botanical treatments was incubated as a control. The experiment was replicated three times, and the radial growth of the fungus, measured in centimeters, was recorded after the 10-day incubation period (refer to Table 2***).***

Table 1: Treatment details

Treatment	Name of the plant botanicals	Botanical name
T0	Control	-
T1	Neem	*Azadirachta indica*
T2	Prosophis	*Prosopis juliflora*
T3	Nerium	*Nerium oleander*
T4	Senna	*Senna alexandrina*
T5	Lantana	*Lantana camara*
T6	Pungam	*Pongamia pinnata*
T7	Coconut	*Cocus nucifera*
T8	Calotropis	*Calotropis procera*

***In vivo* studies on the effect of botanicals on the growth of *Alternaria solani* at the field level**

The trial was conducted at the experimental farm of the Agricultural College and Research Institute in Vazhavachanur, Thiruvannamalai, using the PKM-1 tomato variety, recommended for the rabi/summer season.

The experiment followed a Randomized Block Design (RBD) with eight treatments and three replications, each

plot measuring 2m x 2m. The land was prepared by plowing with a cultivator and using a rotavator to create a fine-textured bed. The plots were laid out according to the predetermined plan, and farmyard manure was applied during planting. The PKM-1 tomato seedlings, 27 days old, were planted 60 cm apart between rows and plants, following all prescribed farming practices.

Botanical materials were sourced from the college and nearby villages in Vazhavachanur and prepared at a 10% concentration. After washing and chopping into small pieces, the botanicals were ground using a pestle and mortar. The extracts were filtered through muslin cloth into glass beakers, repeating this process for all eight botanicals.

The botanical extracts were sterilized in an autoclave at 15 lb pressure and 121ºC for 20 minutes. These sterilized extracts were then sprayed on tomato plants at a 10% concentration, with three replications, on two occasions. For biometric observations, ten leaves per plant were examined to assess the intensity of blight based on the percentage of leaf area damaged, focusing on leaves affected by early blight. The disease index was calculated using McKinney's formula(1923).

$$\text{Infection Index or Disease Intensity of grading} = \frac{\text{Sum of all disease grade}}{\text{Total number of grade} \times \text{Maximum disease grade}}$$

III. RESULTS

The use of botanicals to control various plant diseases is a well-established practice. In the pursuit of effective measures to control early blight in tomatoes, several botanicals underwent in vitro testing. Following this, a field trial was carried out as a follow-up to the laboratory studies.

Pathogenicity study

The pathogen was successfully isolated from plants exhibiting infection symptoms and subjected to pathogenicity testing on the PKM-1 tomato variety. Initially, the disease appeared as small, isolated, and scattered pale brown spots on the leaflets. As the infection progressed, these spots merged, causing the affected leaves to dry out. The infected leaves showed distinct concentric rings within the lesions. The infection began on the lower leaves and moved upward. Dark spots also appeared near the ground level at the base of the stem, gradually encircling it. Additionally, dark brown sunken spots developed on the fruits, leading to premature dropping of immature fruits and a reduction in overall fruit size.

***In vitro* studies**

The relative effectiveness of different botanicals was assessed in vitro using the poisoned food technique. The percentage inhibition of *Alternaria solani* growth at various botanical concentrations was determined and compared to the control, as outlined in the "Materials and Methods" section.

Effect of botanicals on the radial growth of *Alternaria solani*

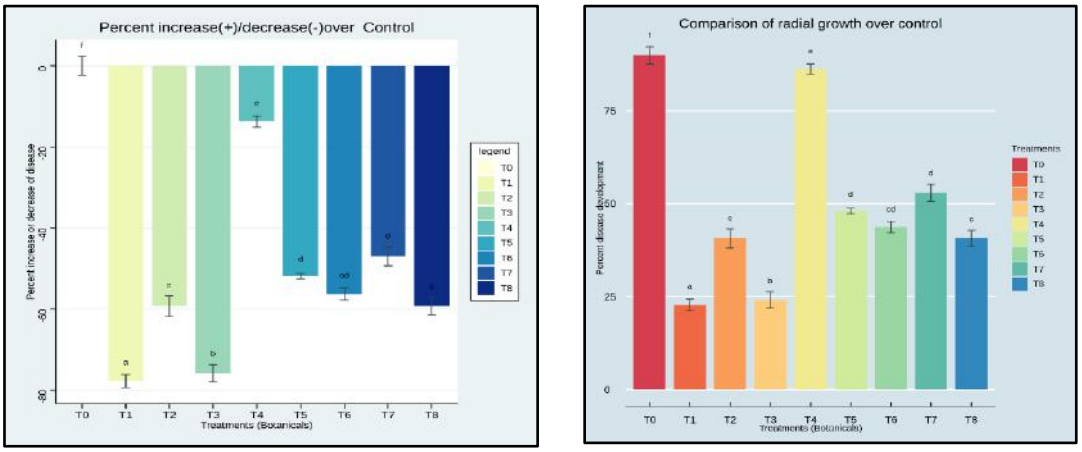
The effect of eight botanicals on pathogen growth was examined by incorporating them into Potato Dextrose agar medium at 10% concentrations. These cultures were incubated for 10 days, and the growth diameter of the pathogen was meticulously measured. A control group was also included, where no fungicide was added to the medium. The results averaged from three replications, are presented in Table 2.

Plate 1: Alternaria solani on Potato Dextrose Agar plate

Neem leaf cold extract demonstrated the highest level of inhibition among the botanicals tested, achieving a notable 77.8% reduction at a 10% concentration compared to the control. Following closely, Nerium showed significant inhibition at 75.9%, whereas the control group exhibited 0% inhibition. In contrast, Senna showed limited effectiveness in inhibiting the pathogen's growth, indicating relatively lower performance.

Table 2: Effect of different concentrations of botanicals on the radial growth of Alternaria solani

Treatment	Mean	Diameter of growth (mm) 10% concentration	
		Percent increase (+) or decrease (-) over control	Percent disease development
T0	90	0	0
T1	20.0	-77.8	22.8
T2	35.8	-59.3	40.7
T3	21.6	-75.9	24.1
T4	77.8	-13.7	86.3
T5	43.3	-51.9	48.1
T6	39.4	-56.3	43.7
T7	47.8	-47.0	53.0
T8	35.7	-59.3	40.7



(A) **(B)**

Fig.1: (A) Bar plot depicts the Percent increase (+) or decrease (-) over control, (B) Percent disease development

Efficacy of certain botanicals on the control of tomato early blight caused by *Alternaria solani*

Disease incidence

The field trial aimed to investigate the occurrence of early blight in the PKM-1 tomato variety, focusing on the impact of *Alternaria solani* and the application of botanicals. The findings, which include average values from three replicates, are outlined in Table 3.

Table 3: Effect of certain botanicals on early blight intensity in tomato cultivar PKM1 based on Grading of Alternaria solani affected leaves

Treatment	Name of the plant botanicals	Percent disease index (%)
T0	Control	40.8
T1	Neem	28.0

T2	Prosophis	36.2
T3	Nerium	30.2
T4	Senna	38.5
T5	Lantana	37.2
T6	Pungam	33.2
T7	Coconut	37.7
T8	Calotropis	31.7

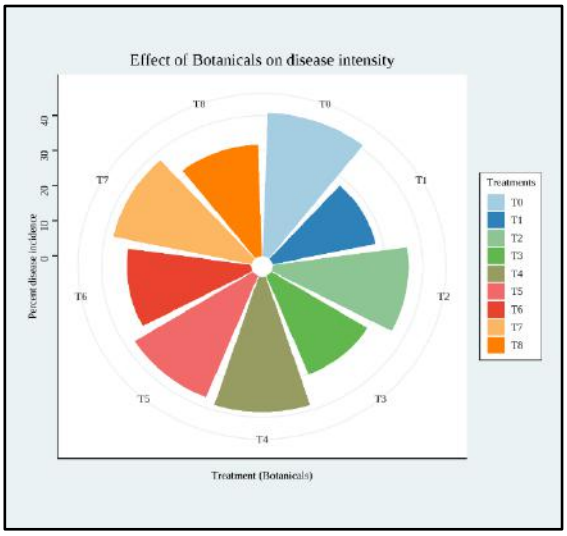


Fig.3: Circular bar plot depicts the effect of botanicals on disease intensity

IV. DISCUSSION

This chapter discusses the outcomes of the field experiment conducted at the Agricultural College and Research Institute, Vazhavachanur, focusing on the topic " Sustainable Management of Tomato Early Blight with Plant Extracts." Within this study, the causal agent of early blight, *Alternaria solani* were isolated and their pathogenicity was confirmed.

Throughout the investigation, *Alternaria solani* caused dark brown to black spots with concentric rings on leaves, petioles, stems, and fruits, resulting in yield losses ranging from 25 to 50 percent. Previous research by scholars Goussous *et al.*, (2010) extensively explored disease incidence and botanical control strategies. This study specifically focuses on evaluating various botanicals effectiveness against early blight in tomatoes, both in laboratory settings (in vitro) and real-world conditions (in vivo). The findings emphasize the efficacy of fungicides at different concentrations in inhibiting *Alternaria solani* under controlled and field conditions. Additionally, the study examines the impact of selected botanicals on disease incidence caused by *Alternaria solani* infection.

Effect of different concentrations of botanicals on the *in vitro* growth

In this study, the efficacy of botanicals in controlling the early blight of tomatoes caused by *Alternaria solani* was investigated under laboratory conditions. Eight botanicals such as Neem, Prosopis, Nerium, Senna, Parthenium, Pungam, Coconut, and Calotropis were tested at a concentration of 10 percent. The parameters selected to evaluate their fungicidal effectiveness included measuring the radial growth of *Alternaria solani.*

The results showed that all tested botanicals exhibited superior efficacy in inhibiting the radial growth of *Alternaria solani* compared to the control group. Among these botanicals, neem demonstrated the highest effectiveness in inhibiting radial growth.

V. CONCLUSION

In conclusion, the utilization of plant extracts presents a promising avenue for the sustainable management of early blight in tomatoes caused by *Alternaria solani*. This study demonstrated the efficacy of botanical extracts from eight plants: Neem, Prosopis, Nerium, Senna, Lantana, Pungam, Coconut, and Calotropis at a 10% concentration in inhibiting the radial growth of the pathogen. These botanicals not only showed significant fungicidal activity but also offered environmentally friendly alternatives to synthetic fungicides, aligning with principles of sustainable agriculture. Future research should focus on optimizing application methods and concentrations for different environmental conditions, as well as assessing their economic viability and scalability in commercial tomato production systems.

REFERENCES

[1] Adhikari, P., Oh, Y. and Panthee, D.R., 2017. Current status of early blight resistance in tomato: an update. *International Journal of Molecular Sciences*, *18*(10), p.2019.

[2] Ainsworth, G.C., 1981. *Introduction to the history of plant pathology*. Cambridge University Press.

[3] Cammarano, D., Jamshidi, S., Hoogenboom, G., Ruane, A.C., Niyogi, D. and Ronga, D., 2022. Processing tomato production is expected to decrease by 2050 due to the projected increase in temperature. *Nature Food*, *3*(6), pp.437-444.

[4] Christ, B.J. and Maczuga, S.A., 1989. The effect of fungicide schedules and inoculum levels on early blight severity and yield of potato. *Plant disease*, *73*(8), pp.695-698.

[5] Goussous, S.J., Abu el-Samen, F.M. and Tahhan, R.A., 2010. Antifungal activity of several medicinal plant extracts against the early blight pathogen (*Alternaria solani*). *Archives of Phytopathology and Plant Protection*, *43*(17), pp.1745-1757.

[6] Guan, Z., Biswas, T. and Wu, F., 2018. The US tomato industry: An overview of production and trade: FE1027, 9/2017. *EDIS*, *2018*(2).

[7] Kaur, C., George, B., Deepa, N., Singh, B. and Kapoor, H.C., 2004. Antioxidant status of fresh and processed tomato-A review. *Journal of Food Science and Technology-Mysore*, *41*(5), pp.479-486.

[8] Knapp, S. and Peralta, I.E., 2016. The tomato (*Solanum lycopersicum* L., Solanaceae) and its botanical relatives. *The tomato genome*, pp.7-21.

[9] Adugna, D., G., D.-S., & Leta, A. (2024). Yield Response of Chick Pea (Cicer arietinum L.) Varieties to NPS Fertilizer. In International Journal of Horticulture, Agriculture and Food science (Vol. 8, Issue 1, pp. 19–27). https://doi.org/10.22161/ijhaf.8.1.3

[10] Suresha, K. (2022). Electron Diffusion and Phonon Drag Thermopower in Silicon Nanowires. In International Journal of Chemistry, Mathematics and Physics (Vol. 6, Issue 1, pp. 01–04). AI Publications. https://doi.org/10.22161/ijcmp.6.1.1

[11] McKinney, H., 1923. Influence of soil temperature and moisture on infection of wheat seedlings by helmin. *J. Agric. Res*, *26*, p.195.

[12] Meena, M., Gupta, S.K., Swapnil, P., Zehra, A., Dubey, M.K. and Upadhyay, R.S., 2017. Alternaria toxins: potential virulence factors and genes related to pathogenesis. *Frontiers in microbiology*, *8*, p.1451.

[13] National Horticulture Board. (2018). *Horticulture Statistics at a Glance*.