Exploring Natural Solutions: Botanical Approaches for Controlling Early Blight in Tomato Plants under Laboratory Conditions

ABSTRACT:
Around the world, *Alternariasolani* is the culprit behind the deadly and devastating early blight of tomatoes. To control the mycelial growth of *A. solani* in this investigation, a concentration of 10% for each plant extract was examined using the poison food technique. In comparison to the control, the pathogen mycelial growth was greatly suppressed by all examined extracts. With a 90.54% inhibition at 10% concentration, garlic clove extract proved to be the most successful of the extracts. Other extracts that showed promise were neem leaf extract (87.83%), ginger (83.78%), eucalyptus (75.67%), bael (71.67%), onion bulb extract (68.67%), and ashwagandha (63.51%). On the other hand, with a mycelial growth of 35 mm and 52.70% inhibition, lantana proved to be the least successful. After seven days of incubation at 24°C, the chemical fungicide mancozeb proved to be the most effective overall, offering a 93.24% inhibition at a 0.25% dose. Chemicals pose health dangers even though farmers use them extensively to control tomato rot. This study provides useful information for farmers by highlighting appropriate plant extracts as less risky substitutes for treating tomato early blight.
KEYWORDS: Early blight of Tomato, *Alternariasolani*, Plant extracts, Natural fungicides, biological control, Garlic clove extract, Neem leaf extract

Introduction

Globally, tomatoes are a vital vegetable crop that are farmed. It is a great source of iron, calcium, potassium, phosphorus, sulfur, and other important minerals. It is also a rich source of vitamins A, B, and C. Tomato plants, however, are extremely susceptible to a wide range of diseases, such as fungi, viruses, and bacteria, which have a negative impact on quality and production [18, 19]. The most damaging of the fungal diseases is early blight, which is brought on by *Alternariasolani* (Ellis and Martin) (Biradar et al., 2021) [1,7]. This pathogen can infect tomatoes at all stages of growth, causing serious damage over the country in the form of diseases such fruit lesions, stem rot, and leaf blight [4, 18], which can reduce output by 50% to 86% in the field and after harvest [19, 9].

Historically, a variety of conventional fungicides have been used to treat tomato early blight (Neha et al., 2021) [8, 14, 22]. However, the search for alternate *A. solani* control strategies has been driven by the development of resistance in common fungal diseases to these fungicides, as well as worries about fungicide residues and related hazards to human health. It is imperative to assess the effectiveness of botanical agents and their combinations in combating early blight. Botanical plants are becoming more important in integrated disease management due to increased consumer and producer knowledge and a shift toward organic products [5, 15, 20, 21,23-26]. The purpose of this study is to evaluate the possibility of safe for humans and other living things botanical plant extracts as a botanical control against *A. solani*, a pathogen that causes large yield losses in tomatoes and causes early blight.

MATERIALS AND METHODS

The experiment was conducted in the Department of Plant Pathology and Agricultural microbiology, College of Agriculture, Pune, during 2017-2018, in order to evaluate the efficacy of different plants extracts against early blight of tomato.

Isolation of pathogen

An infected tomato plant showing early blight symptoms was collected from the field and thoroughly washed with water. The plant was then placed between blotting paper to remove any excess moisture. In a sterile environment, the infected leaves were cut into small pieces and surface sterilized with 0.1% mercuric chloride for 10 seconds. After sterilization, the pieces were rinsed two to three times with sterilized distilled water and aseptically transferred to solidified potato dextrose agar (PDA) in petri plates. The inoculated petri plates were incubated in a BOD incubator at 25°C to promote the mycelial growth of the pathogen. The resulting pure fungal culture was subsequently sub-cultured and preserved for further analysis.

Preparation of plants Extract

"Plant parts were crushed with sterilized water and filtered through muslin cloth to produce a 100% crude extract. The required amount of each plant extract was then separately added to achieve the desired concentration using potato dextrose agar (PDA) as the nutrient medium. The plant extracts were thoroughly mixed by stirring, and approximately 10 ml of the extract-containing medium was poured into each 9 cm petri dish, allowing it to solidify. A PDA plate without any plant extract served as the control. The inoculated plates were incubated at 26±1°C in a BOD incubator for twelve days. The colony diameter was recorded, and the percent inhibition was calculated using the formula". [27]

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

I = percent inhibition of mycelial growth,C = radial growth of fungus in control,
T = radial growth of fungus in treatment

RESULT AND DISCUSSION

In-vitro assessment of plant extracts and fungicide against *Alternariasolani* was done by poisoned food technique. The treatments evaluated after seven days of colony growth by taking average mycelial growth and inhibition percentage.In present study, all the tested extracts at 10% concentration were significantly ($P \leq 0.01$) reduced linear growth and increased inhibition percentage compared to control. Among the tested plant extracts, garlic clove extract was found expressively most efficacious and indicated maximum percentage inhibition that was 90.54% at 10% concentration followed by Neem leaf extract (87.83%), Ginger (83.78%), Eucalyptus (75.67%), Bael (71.67%), Onion bulb extract (68.67%) and Ashwagandha (63.51%) respectively. While, Lantana (52.70%), was the least effective extract with 35 mm mycelial growth. Mancozeb was most effective fungicide against early blight of tomato percentage inhibition was 93.24% at 0.25% conc. gave the best control over mycelial development.

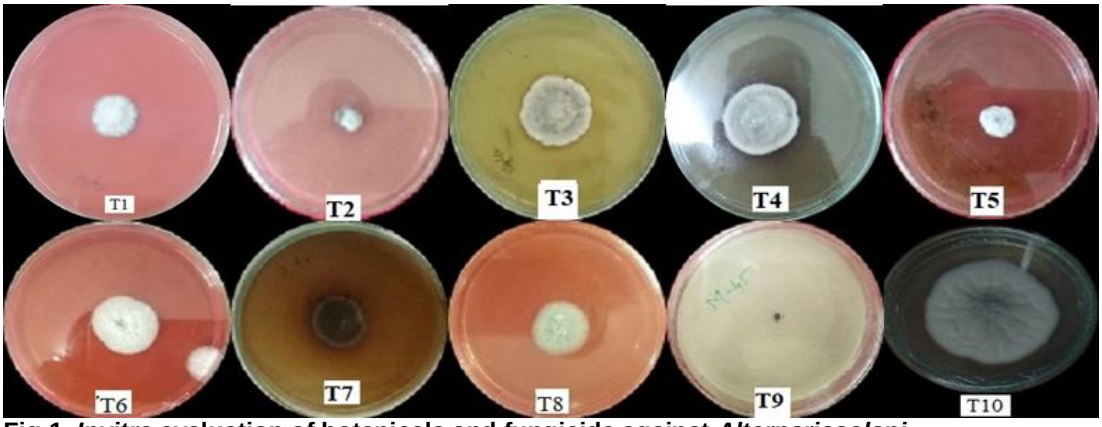

Fig 1. *Invitro* evaluation of botanicals and fungicide against *Alternariasolani*

In case of plant extracts, garlic was found to be significant and gave maximum percentage inhibition i.e. 90.54 at 10%. While neem was the second most effective extract followed by ginger, onion and eucalyptus at 10% concentration which was found to be at par with each other. The results revealed that the concentrations of all the botanicals compressed the growth of *Alternariasolani,* however, the garlic application at 10% concentration revealed determined control over the mycelial development of *Alternariasolani* after seven days of incubation at 24^0C. The inhibitory effect of these extracts may be due to their direct lethal effect on the pathogen growth or antimicrobial activity against fungal pathogens under *invitro*.

The results of the present study align with the findings of Deshmukh (2020), Naik et al. (2020) and Biradar et al. (2021), who investigated various plant oils and products. Specifically, clove extract from *Allium sativum* at 10% concentration demonstrated the highest reduction in mycelial growth, achieving 100% inhibition. This was followed by a 10% leaf extract of *Daturametel*, which inhibited growth by 68.44%, and a 3% oil extract of *Azadirachtaindica*, which showed a 59.88% reduction in mycelial growth. Biradar et al. (2021) and Sahu et al. (2014) also tested "plant extracts and reported antifungal activities. Extracts from *Azadirachtaindica* (neem), *Daturastramonium* (datura), and *Withaniasomnifera* (ashwagandha) exhibited significant antifungal effects". In particular, the leaf extract of *W. somnifera* was the most effective in inhibiting the

mycelial growth of *Alternariasolani*, with a reduction of 62.56%, followed by *D. stramonium* at 34.65% and *A. indica* at 25.27%.

Table1. *In vitro* evaluation of plant leaf extracts and fungicide against *Alternariasolani*
* = Mean of four replications, Figure in parenthesis are Arcsine transfer values

Tr.No.	Treatments	Mean colony diameter* (mm)	Inhibition over control (%)
1	Ginger	12.02 (20.69)	83.78
2	Garlic	6.9 (15.21)	90.54
3	Ashwgandha	27.1 (31.42)	63.51
4	Lantana	35 (36.22)	52.70
5	Neem	8.93 (17.43)	87.83
6	Onion	23 (28.73)	68.91
7	Eucalyptus	18.3 (24.98)	75.67
8	Bael	21.1 (27.49)	71.67
9	Mancozeb	5 (12.91)	93.24
10	Control	74.25 (59.5)	00
SE(m)±		**0.44**	
CD (5%)		**1.29**	

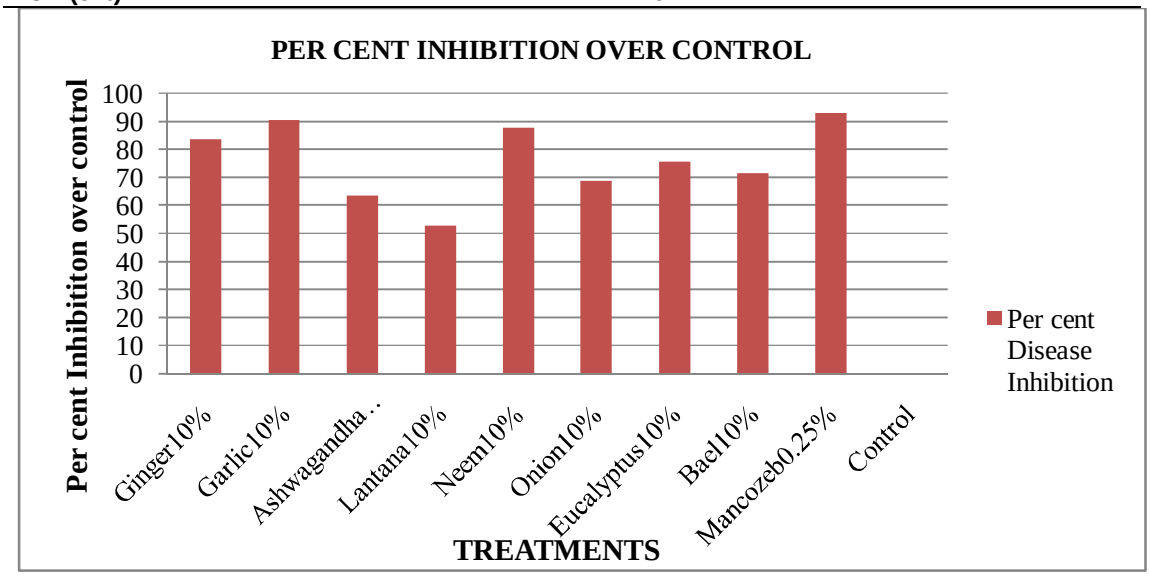

Fig. 2 Inhibition of colony growth of *Alternariasolani* over control

CONCLUSION

Early blight of tomato is a severe disease that leads to significant yield and quality losses. Based on the summarized experimental findings, it can be concluded that plant extracts possess antifungal properties that can be effective against *Alternariasolani*. Utilizing suitable plant extracts as antifungals provides a safer alternative to chemical fungicides, which pose health risks to farmers and consumers and can damage plants and fruits. Notably, extracts from garlic and neem have proven highly effective against the pathogen. Given the variety of plants with medicinal properties, some extracts are more effective than others against *A. solani*. This investigation offers valuable insights for farmers, guiding the selection of effective plant extracts to manage.

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REFERENCES

1. Biradar PD, Suryawanshi AP, Patait NN. In vitro bio efficacy of bioagents against *Alternariasolani* and *Colletotrichumcapsici*, causing tomato fruit rot. The Pharma Innovation Journal. (2021);10(12):1773-1776.
2. Biradar PD, Suryawanshi AP, Patait NN. In vitro bio-efficacy of phyto extracts against *Alternariasolani* and *Colletotrichumcapsici*, causing tomato fruit rots. The Pharma Innovation journal. (2021);10(12):1784-1787.
3. Biradar PD, Suryawanshi AP, Giri VV. In vitro bio efficacy of essential oils against *Alternariasolani* and *Colletotrichumcapsici*, causing tomato fruit rots. ThePharma Innovation Journal. (2021);10(12):1671-1674.
4. Jones LR, Grout AJ. Notes on two species of *Alternaria*. Bulletin of the Torrey Botenical Society. 1897; 24:254- 258.
5. Kadam NP, Mulekar V. G., BiradarPratiksha D.* and Suryawanshi A. P. In vitro Efficacy of Aqueous and Solvent Phytoextracts against Ralstoniasolanacearum (Poster Presentation) National symposium on Probing beneficial microorganism for next green revolution, Akola, India (2021). https://www.researchgate.net/publication/370108833_Thematic_Area_Novel_approaches_for_the_management_of_plant_diseases_In_vitro_Efficacy_of_Aqueous_and_Solvent_Phytoextracts_against_Ralstonia_solanacearum
6. Agrios GN. Plant Pathology. 5th edition, Alsevier Academic Press, New Yark, 2005, 665.
7. Mathur K, Shekhawat KS. Chemical control of early blight in Kharif sown tomato. Indian Journal of Mycology Plant Pathology. 1986; 16:235-238.
8. Patil MJ, Ukeyand SP, Raut BT. Evalution of Fungicides and Botenicals for the management of Early Blight (*Alternariasolani*) of tomato. PKV Research Journal. 2002; 25(1):49-51.
9. Nivedha M, Ebenezar EG, Kalpana K, Kumar R. *In vitro* antifungal evaluation of various plant extracts against leaf blight disease of *Jasminum grandiflorum* caused by *Alternariaalternata* (Fr.) Keissler, Journal of Pharmacognosy and Phytochemistry. 2019; 8(3):2143- 2147.
10. Sahu DK, Khare CP, Patel R. Eco friendly management of early blight of tomato using botanical plant extracts. Journal of Industrial Pollution Control. 2014; 30(2):215- 218.
11. Arunakumara, K.T. (2006). Studies on *Alternariasolani* (Ellis and Martin) Jones and Grout causing early blight of tomato. M. Sc (Ag) thesis, University of Agricultural Sciences, Dwarwad.
12. Chourasia, P. K.,A. A. Lal and S. Simon, (2013.) Effect of fungicides and botanicals against early blight of tomato caused by *Alternariasolani*. *InternationalJournalofAgriculturalScienceresearch* 3(3),151-155.
13. Nashwa, and M.A. Sallam, (2012). Control of tomato early blight disease by certain aqueous plant extracts. *PlantPathologyJournal* 10(4): 187-191.
14. Neha NP, AP Suryawanshi, PD Biradar, VR Wadhave. Efficacy of Fungicides against Phyllostictazingiberi, causing Phyllosticta leaf spot of ginger in In vitro conditions. Pharma Innovation Journal 2021;10(12):1788-1792.
15. Neha NP, AP Suryawanshi, PD Biradar, VR Wadhave, MR Kharade. Bioefficacy of Bioagents and Phytoextracts against Phyllostictazingiberi, causing Phyllosticta leaf spot of ginger in In vitro conditions. Pharma Innovation Journal 2021;10(12):1804-1809.
16. Singh, P. C. and D. Singh. (2006). *Invitro* evaluation of fungicides against *Alternariaalternata*. *Ann. Pl. Protec. Sci.,*14 (2): 500-502.

17. Deshmukh HV, Deokar CD, Khaire PB and Brahmane PR. Efficacy of different botanicals against the *Alternariasolani* under in vitro conditions. Journal of Pharmacognosy and Phytochemistry. (2020) 9(6): 1986-1989.
18. Khaire PB, Mane SS and Pawar SV. Identification and Management of Fungal Diseases of Tomato-A review. 1 (1) Agri meet Multidisciplinary e-Magazine. (2021) 1-18. *https://www.researchgate.net/publication/348322121_IDENTIFICATION_AND_MANAGEMENT_OF_FUNGAL_DISEASES_OF_TOMATO-A_REVIEW*.
19. Khaire PB and Hake LG. Some Important Post Harvest Diseases of Tomato and Their Management. Popular Kheti. (2018) 6 (3) 80-86. *https://www.researchgate.net/publication/333203668_Some_Important_Post_Harvest_Diseases_of_Tomato_and_Their_Management.*
20. Naik SC, Narute TK, Narute TT and Khaire PB. Effects of selected biological control agents and plant extracts on early blight disease management and yield of cherry tomato. Journal of Pharmacognosy and Phytochemistry. (2020) 9(5): 587-592. *https://www.researchgate.net/publication/348884009_Effects_of_selected_biological_control_agents_and_plant_extracts_on_early_blight_disease_management_and_yield_of_cherry_tomato.*
21. Naik SC, Narute TK, Narute TT and Khaire PB. In vitro efficacy of plant extract (botanicals) against *Alternariasolani* (early blight of tomato). Journal of Pharmacognosy and Phytochemistry. (2020) 9(5): 614-617. *https://www.researchgate.net/publication/348884330_In_vitro_efficacy_of_plant_extract_botanicals_against_Alternaria_solani_early_blight_of_tomato*.
22. Deshmukh HV, Deokar CD, Raghuwanshi KS, Khaire PB and Brahmane PR. Efficacy of different fungicides against the *Alternariasolani* under in vitro conditions. J PharmacognPhytochem 2020;9(6):1957-1960.
23. Dole P. D, Gaikwad S. D, and ChavanDigvijay. 2024. “Optimizing Tomato Health: Holistic Approach to Early Blight Disease Management”. Journal of Advances in Biology & Biotechnology 27 (6):492-97. https://doi.org/10.9734/jabb/2024/v27i6909.
24. Choudhary ,Sunita, Rajani Singh Sasode, Pinki Devi Yadav, RanjanaMeena, and Pooja Yadav. 2024. “Management of Early Blight of Tomato (AlternariaSolani) through Application of Plant Extracts and Fungicides”. International Journal of Plant & Soil Science 36 (1):238-45. https://doi.org/10.9734/ijpss/2024/v36i14354.
25. Horsfield A, Wicks T, Davies K, Wilson D, Paton S. Effect of fungicide use strategies on the control of early blight (Alternariasolani) and potato yield. Australasian Plant Pathology. 2010 Jul;39:368-75.
26. Feliziani E, Santini M, Landi L, Romanazzi G. Pre-and postharvest treatment with alternatives to synthetic fungicides to control postharvest decay of sweet cherry. Postharvest Biology and Technology. 2013 Apr 1;78:133-8.
27. Sen M, Chandra R, Tiwari AK. Evaluation of different plant extracts against Alternariasolani (Ellis and Martin) sorauer caused early blight of tomato (Solanumlycopersicum L.). Journal of Pharmacognosy and Phytochemistry. 2020;9(3):195-7.