International Journal of Economic Plants

https://ojs.pphouse.org/index.php/IJEP

IJEP September 2025, 12(5): 01-05

Crossref

Article IJEP6477a

Full Research

Stress Management

Doi: HTTPS://DOI.ORG/10.23910/2/2025.6477a

Insights of Early Blight of Tomato in Punjab

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Article History

Received on 28th June, 2025
Received in revised form on 18th August, 2025
Accepted in final form on 05th September, 2025
Published on 17th September, 2025

Abstract

The experiment was conducted during *rabi* 2024 (February–April) at P.G. Department of Agriculture, Khalsa College, Amritsar to study disease level and epidemiological factors for accessing early blight of tomato, incited by *Alternaria solani*. A periodic survey of early blight of tomato was carried out in two districts of Punjab, namely Amritsar and Gurdaspur in the months of March–April, 2024. Disease incidence and disease severity were calculated at 6 places. The disease incidence of early blight of tomato ranged from 10.00 to 35.00% while, disease severity ranged from 9.67 to 26.66%. Maximum disease incidence of 35.00% was recorded in Loharka Kalan while minimum of 10.00% was observed in Balpurian. In case of disease severity, maximum was observed in Loharka Kalan (26.66%) while, minimum was observed in Balpurian (9.67%). Overall data indicated that the disease intensity was higher in Amritsar district than Gurdaspur district. The culture of *Alternaria solani* was blackish grey or whitish grey with a tint of olive green. The mycelium of the fungus was profusely branched and septate with hyaline to light brown colour. The development of early blight of tomato in relation to weather parameters was also observed. Results showed that maximum temperature, minimum temperature and wind speed are positively correlated with PDI whereas, rainfall and relative humidity are negatively correlated.

Keywords: *Alternaria solani*, disease intensity, survey, tomato, temperature, humidity

1. Introduction

Tomato (*Solanum lycopersicum* L.) also known as Poor man's orange is a diploid (2n=24) crop and belongs to the Solanaceae family. Tomatoes are edible berries and are widely consumed as fresh or processed food products worldwide in the form of canned tomatoes, sauce, juice, ketchup, soup, etc. (Campestrini et al., 2019; Li et al., 2021).Universally, tomato treated as protective food based on its nutritional values such as lycopene, flavonoids, potassium and vitamins. Red color of tomato is due to presence of lycopene (Sepat et al., 2013). These fruits also have a high content of nutrients and bioactive substances which are beneficial for a healthy body, a healthy skin, and weight loss, and which may ameliorate or prevent various human chronic degenerative diseases (Ali et al., 2021).

Globally tomato is grown over an area of 46.16 lakh ha with production of 186 MT (Anonymous, 2023). China is the largest producer of tomato in the world, producing approximately 57.5 mt, followed by India (19.5 mt) and USA (11.1 mt) (Anonymous, 2023). In India, total area under tomato cultivation is 840 thousand ha with annual production of 20,331 thousand mt (Anonymous, 2023). In Punjab, it is cultivated over an area of 10.27 thousand ha with annual production of 2,66,905 mt (Anonymous, 2023). In Punjab, it is mainly grown in Amritsar, Ropar, Jalandhar and Hoshiarpur districts. Where as in Amritsar, tomato is grown over an area of 1,756 ha with production of 46,285 mt (Anonymous, 2023).

A number of fungal and viral diseases affect tomatoes. Major causes of parasitic diseases to tomato crop are bacteria, mycoplasmas, fungi, viruses, viroids and parasitic phanerogams. Similarly, non-parasitic diseases are caused due to extremes light, heat, soil moisture and pH by nutritional imbalances (Bhangare, 2022). Tomato crop is affected by many diseases among which early blight caused by *Alternaria solani* is most destructive disease of the tomato (*Solanum lycopersicum* L.) in tropical and subtropical countries. The disease in severe cases can lead to complete defoliation and is very damaging on tomato in regions where there is heavy dew, rainfall, high humidity, and fairly high temperatures (Rotem and Reichert, 1964). The disease occurs at all stages of plant growth and affect all above ground parts of tomato including leaf, stem and fruits (Akhtar et al., 2019; Mphahlele

et al., 2020). *Alternaria* can cause defoliation, drying off of twigs and premature fruit drop and thus leading to losses of up to 79% in fruit yield (Adhikari et al., 2017; Kaur et al., 2020). Early blight symptoms appear on the leaves as circular lesions, 1.5 cm in diameter with dark concentric circles (Adhikari et al., 2017). Leaf blight initiates on the mature or lower leaves and progresses upward through the canopy . Infected leaves become weakened and then die (Ghorbanpour et al., 2018; Mahawar et al., 2020). Early blight fungus can invade the ripened tomato fruit near the point of attachment to the stem and may show rings (Kumar et al., 2018).

Living and non-living organisms such as biotic and abiotic stress/disease are responsible for around 22% of crop yield loss in agriculture (Kaur et al., 2024). Early blight is a significant constraint in tomato crops worldwide, particularly in tropical and temperate regions. Pathogen can destroy tomato plants, with yield losses as high as 86.00 per cent (Dhal et al., 2017). In Kenya, prevalence of early blight in the farmer field was 85% and 90%, farmers considered it as a major cause of crop loss (Nuwamanya et al., 2023). In Bangladesh, *Alternaria solani* may cause crop losses ranging from 50–86% in fruit yield and 20–40% in seedling establishment (Parvin et al., 2021). In India, tomato crop is damaged every year due to severe infection of *Alternaria solani*. The disease severity was recorded up to 90% in Varanasi region of UP (Pandey et al., 2002). Various researchers from throughout the world have acknowledged the link between disease severity and the weather (Devi and Chanu, 2012). Weather parameters like minimum temperature, evening relative humidity, morning relative humidity rainfall, number of rainy days have significant effect on per cent disease index (PDI) progressing at a linear rate as the growth of the plant advances (Sudarshan et al., 2022).

2. Materials and Methods

2.1. Survey

The experiment was conducted during *rabi* 2024 (February – April) at Amritsar and Gurdaspur districts of Punjab. Surveys were carried out to know the disease prevalence of early blight of tomato.. Data was taken from three fields from each location and ten plants were randomly selected in a field. Disease incidence and disease severity were recorded and samples were collected for further use. Disease incidence was recorded by counting the number of infected plants in a field and disease severity was recorded on 0–5 scale. The per cent disease incidence (PDI) was calculated as below

Disease incidence (%)=(Total number of infected plants/Total number of plants observed)× 100

Disease severity was measured by using 0–5 scale with modification described by Pandey et al. (2003)

Disease severity (%) ={Sum of all individual ratings/ (Total number of rating×Maximum disease grade)} ×100

Rating	Description
0	Free from infection
1	One or two necrotic spots on few lower leaves of plant, covering nearly 1–10% surface area of plant
2	A few isolated spots on leaves covering 11–25% surface area of plant
3	Many spots coalesced on the leaves covering 26–50% of the surface area of the plant.
4	Concentric rings on the stem petiole, fruit covering 51–75% leaf area of the plant
5	Whole plant blighted leaf and fruits starting to fall covering more than 75% leaf area of the plant

2.2. Morphological and cultural characteristics

Potato dextrose agar media (PDA) was used as a growth media to grow the test fungus and cultural and morphological studies were carried out. For cultural characteristics the colour of the colony, mycelial growth and type of margin were studied after 14 days of incubation (Nagesh et al., 2021). From 14 days old culture slides were prepared and viewed under compound microscope, morphological characteristics based on macro and microscopic features such as conidia color, size and septation were made.

2.3. Epidemiological studies

To study the epidemiology of early blight of tomato, 5 weather parameters (maximum temperature, minimum temperature, wind speed, rainfall, and relative humidity) were studied in 2024. Severity of early blight was recorded at seven days interval starting from twenty days after planting on using 0–5 grade scale as given by Pandey et al. (2003). The Plant Disease Index (PDI) was calculated using the formula (Wheeler, 1969).

The experiments were conducted under open field conditions. No protection was given against the disease. Weather data with respect to maximum and minimum temperature, wind speed, rainfall and relative humidity were obtained averaged for seven days. The weather parameters were correlated to weekly plant disease index by calculating the Karl Pearson's correlation coefficient (r). Correlation coefficient values were tested individually for their significance at 5% probability level using following formula:

$t=r\sqrt{(n-2)}/\sqrt{1-r}$

Where,

t: test of significance, r: correlation coefficient and n: number of observations

3. Results and Discussion

3.1. Survey

The survey conducted was conducted at various locations of Amritsar and Gurdaspur districts of Punjab. The data collected is enlisted in Table 1 given below along with the longitude and latitude of the locations. The disease incidence of early blight

of tomato ranged from 10.00 to 35.00% while, disease severity ranged from 9.67 to 26.66%. In Amritsar district maximum disease incidence of 35.00% was recorded in Loharka Kalan followed by Khalsa College (25.00%), while minimum disease incidence of 20.00% was observed in Bhlaipur Purba. Whereas in Gurdaspur district, Warraich village showed maximum disease incidence of 30.00% while minimum were observed in Balpurian (10.00%). In Amritsar district, maximum disease severity was observed in Loharka Kalan (26.66%) and minimum in Bhlaipur Purba (15.83%). Whereas in Gurdaspur district, it was found to be maximum in Warraich (20.83%) and minimum was observed in Balpurian (9.67%). Overall data showed that the disease incidence and disease severity was higher in Amritsar district than Gurdaspur district (Figure 1 and 2).

Our results are in corroborated with Abhinandan et al. (2004) who showed the heavy incidence of Alternaria blight

Table 1: Disease incidence and disease severity at different locations

Sl. No.	Districts	Villages	Latitude °N	Longitude °E	Disease incidence (%)	Disease severity (%)
1.	Amritsar	Loharka Kalan	31.7333	74.8683	35.00	26.66
		Bhlaipur Purba	31.6214	75.2158	20.00	15.83
		Khalsa College	31.6176	74.9286	25.00	21.67
2.	Gurdaspur	Kala Nangal	32.0583	75.3609	25.00	18.33
		Balpurian	32,0833	75.3000	10.00	9.67
		Warraich	31.5993	75.1982	30.00	20.83

Loharka Kalan Bhlaipur Purba Khalsa College

Figure 1: Survey conducted in Amritsar district of Punjab

Balpurian Kala Nangal Warraich

Figure 2: Survey conducted in Gurdaspur district of Punjab

(*Alternaria solani*) on tomato plant in Punjab. They reported that disease incidence ranged from 9.3–49.5% and 8.2–25.3% during the years 2000 and 2001, respectively

3.2. Cultural and morphological characteristics

Upon studying the cultural characteristics the culture of *Alternaria solani* grown in petri plates was blackish grey or

whitish grey in colour with a tint of olive green when observed after about 14 days of inoculation. The mycelial growth was about 90 mm. The appearance of the colony was cottony and spreading. The mycelium of the fungus was profusely branched and septate with hyaline to light brown colour. Conidia (15–19x150–300 µm) were muriform and beaked (2–5 µm). It had both transverse (9–11) and longitudinal (2–3) septa. The above study was in relation to Hassan et al. (2024) who reported that the fungal conidia of *Alternaria solani* were multicellular, brown to pale with 1–6 transverse septa and 1–2 longitudinal septa, with curved beaks of 4.50–11.25 µm long. Figure 3 shows the pure culture of *Alternaria solani* grown on potato dextrose media and its muriform conidia under microscope.

3.3. Epidemiological studies results

Pure culture of *Alternaria solani* Conidia of *Alternaria solani*

Figure 3: Cultural and morphological characteristics of *Alternaria solani*

The analysis of all the parameters revealed that the weather parameters played an important role in disease development. Table 2 contains the data 7 meteorological weeks and weather parameters (maximum and minimum temperature, rainfall, relative humidity, wind speed) along with the plant disease index calculated on weekly basis. From the correlation analysis of PDI with the weather parameters it was concluded that maximum temperature have positive correlation (r=0.818) with PDI, same way minimum temperature (r=0.759) and wind speed (r=0.441) were positively correlated with PDI whereas relative humidity have negative and significant correlation (r=-0.210) and rainfall is also negatively correlated (r=-0.67) with plant disease index as shown in table 2. Roopa et al. (2016) also studied meteorological factors related to development of early blight of tomato and found that per cent disease index (PDI) was progressing at linear rate throughout the plant growth and it was negatively correlated with minimum temperature, relative humidity (morning and evening) and rainfall. While, positively correlated with maximum temperature.

4. Conclusion

Table 2: Effect of different weather parameters on the plant disease index of early blight of tomato

Meteorological weeks/ Duration	Temperature (°C)		Rainfall (mm)	Relative humidity (%)	Wind speed (km hr^{-1})	PDI
	Max	Min				
12 (18–24 march)	32.64	16.01	0.11	40.36	3.14	0.00
13 (25–31 march)	32.77	18.47	4.70	51.33	3.66	3.20
14 (1–7 April)	33.51	17.29	0.00	36.66	2.50	11.10
15 (8–14 April)	35.63	20.07	0.11	35.94	2.81	17.50
16 (15–21 April)	34.97	20.20	2.16	46.01	3.66	28.20
17 (22–28 April)	36.03	21.96	0.97	40.20	2.80	36.60
18 (29 April- 5 May)	34.80	19.20	1.60	39.36	5.03	40.69

The findings from this study demonstrate that early blight of tomato is a prevalent disease in Amritsar and Gurdaspur districts of Punjab. *Alternaria solani* can survive in soil for long duration. The disease intensity highly depends on the weather parameters such as temperature, rainfall, humidity etc. Therefore, there is a need to raise awareness of farmers about the early blight disease and to take early measures to prevent it from spreading.

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