DEVELOPMENT OF MODERN PROCEDURE FOR DISEASE ASSESSMENT TO MEASURE THE HARMFUL EFFECTS OF PATHOGENS

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Abstract

Pathogens inclusion in tomato plants have been reported earlier; however, many farmers remain ignorant to modern techniques for disease evaluation and its impact on plant health due to limited awareness to updated knowledge and instrumentation. This study aims to elaborate on modern methods as compared to traditional procedure used by farmers for disease evaluation and its progression. Observations marked negative effects on key growth parameters, including shoot length, number of leaves, shoot fresh weight, and shoot dry weight, in infected plants in comparison with healthy plants. Disease incidence (DI) and disease severity (DS) were evaluated by reported scales. The results indicated the gradual increase 35% to 75% in DI and 0.4 to 3.9 in DS scores between 40 and 75 days in tomato plants. The findings highlight the significance of disease evaluation technique and suggest the need for improved training and modern tools for disease assessment. This research provides a foundation for development of modern procedure for disease assessment to measure the harmful effects of pathogens on tomato crop productivity.

KEY WORDS: Pathogens, growth parameters, disease assessment, tomato crops, petri-plates and viability of seeds.

Introduction

Tomato (*Solanum lycopersicum* L.) is one of the most important vegetable crop for its nutritional profile and economic importance. However, various pathogens including fungi, bacteria, viruses, and nematodes, poses a serious threat to tomato yield. (Jones et al., 2014). Pathogen attacks have been reported consistently over earlier studies which causes critical challenges for farmers in maintaining plant health and productivity. Pathogen attack produce decline in function of photosynthetic machinery in which chloroplast affected, chlorophyll pigments decrease in numbers with limitation of CO_2 and oxidative stress produce in infected tissue, due to energy production decreases and hence, reduce plant growth, yield and weakens plant defense (Silva et al., 2023). Despite the occurrence of such diseases, there is necessary to learn technical training, instrumentation, effective disease assessment and management procedures particularly in limited resource area where lack of modern knowledge and techniques (Smith & Brown, 2017).

Many farmers still use traditional methods for disease evaluation by visual identification and basic measurements. However, these type of adoption lack precision which lead to delayed or inappropriate management responses. The pathogen infection severely affects plant vigor and growth parameters which reduce shoot length, number of leaves, shoot fresh and dry weights, and ultimately lead to yield losses (Kumar et al., 2019).

It is necessary to understand DI and DS for effective pathogen control strategies. Accurate disease evaluation not overcome the infection but also supports the development of resistant varieties and integrated disease management practices. Therefore, this study was conducted to evaluate the procedure used to assess pathogen attack frequency and their effect on plant health and growth parameters. The findings of this study decrease gap between traditional management practices and modern plant pathology techniques which encourage farmers to adopt improved and modern techniques for sustainable tomato production. The objectives of this research work is: 1) To file traditional farmer-based methods for assessing pathogen attack in tomato plants. 2) To evaluate the effects of pathogen infection on shoot length, number of leaves, shoot fresh weight, and shoot dry weight. 3) To determine disease incidence and severity under pot conditions.

3. Materials and Methods

3.1 Study Area

Pot experiment was conducted in Kharian Distt. Gujrat

3.2 Plant Material

To achieve uniform growth conditions, tomato seedlings were transplanted into sterilized soil. Plant height was measured using a standard measuring scale, while fresh and dry weights were recorded using a digital weighing balance for greater accuracy. Morphological parameters, including shoot length, number of leaves, shoot fresh weight, and shoot dry weight, were evaluated after 40 and 75 days of growth. For dry weight measurements, the plants were oven-dried at 70°C until a constant weight was achieved. All data were collected carefully to assess the impact of pathogen infection on the growth performance of tomato plants.

3.3 Disease Assessment by Farmers

Disease symptoms on tomato plants were monitored visually throughout the experiment. Farmers' traditional methods were considered for initial identification, focusing on visible signs such as wilting, yellowing of leaves, stunted growth, and lesions on stems. Disease incidence and severity were evaluated after 40 and 75 days of growth.

Disease incidence (%) was calculated using the formula (de Rodriguez et al., 2019).

Disease Incidence (%) = (Number of Infected Plants/ Total Number of Plants) × 100

Disease severity was assessed using Disease symptoms on tomato plants were monitored visually throughout the experiment. Farmers' traditional methods were considered for initial identification, focusing on visible signs such as wilting, yellowing of leaves, stunted growth, and lesions on stems. Disease incidence and severity were evaluated after 40 and 75 days of growth.

Disease severity was assessed using a 0–5 scale devised by Kurabachew et al. (2013) based on visual symptom intensity, where:

- 0 = no symptoms (healthy),
- 1 = 1–10% area affected,
- 2 = 11–25% area affected,
- 3 = 26–50% area affected,
- 4 = 51–75% area affected,
- 5 = more than 75% area affected or complete plant death.

The assessment provided quantitative measures to evaluate the impact of pathogen infection on the morphological and physiological traits of tomato plants.

3.4 Statistical Analysis

ANOVA test carried out by using Minitab software for analyzing differences between healthy and infected plants.

4. Results

At 40 days' after infection disease incidence was 35% ± 0.22, which enhanced to 75% ± 0.20 by 75 days in infested control while, disease severity also showed an increasing trend, which increase from 0.4 ± 0.22 at 40 days to 3.9 ± 0.22 at 75 days. These findings suggested that symptoms appear progressively as the infection proceed.

Table-1: Effect of pathogen on disease incidence (%), disease severity on tomato plants

	Disease incidence %		**Disease severity scores**	
Treatment	40 days	75 days	40 days	75 days
Infested	35±0.22 ab	75±0.2 ab	0.4±0.22 bc	3.9±0.2 2a

The increasing disease burden was associated with notable declines in plant growth parameters in infested plants. Compared to non-infested controls, the height of infested plants (HI) was reduced relative to the height of non-infested plants (HNI). Likewise, reductions were observed in root length (RLI < RLNI), fresh weight (FWI < FWNI), and dry weight (DWI < DWNI). These physiological differences suggest that disease infestation adversely affected plant biomass accumulation and overall vigor.

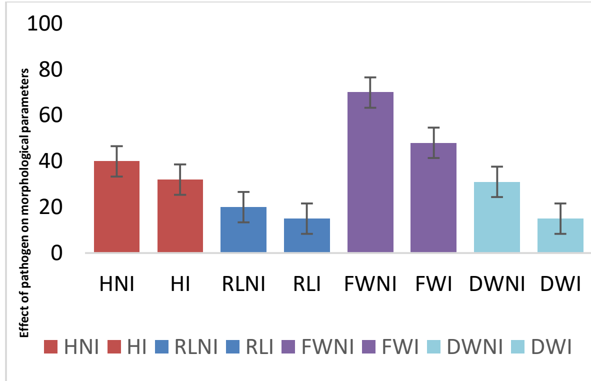

Figure 1: Effect of pathogen on (A) Height (B) Root length (C) Fresh weight and (D) dry weight of tomato plants. Y error bars indicate standard errors of three replications means**.**

NOTE: HNI = Height of non-infested plants; HI= Height of infested plants; RLNI= Root length of non-infested plants; RLI= root length of infested plants; FWNI= fresh weight of non-infested plants; FWI= Fresh weight of infested plants; DWNI= dry weight of non-infested plants; DWI= Dry weight of infested plants.

5. Discussion

The findings reveal that pathogen infection significantly harms tomato plant growth, as indicated by the gradual increase 35% to 75% in DI and DS scores from 0.4 to 3.9 between 40 and 75 days which confirming a time-dependent intensification of disease pressure. Disease progression also illustrated the reciprocal effect by notable reductions in key growth parameters like plant height, root length, fresh weight, and dry weight. These results reflect the pathogen's negative impact on nutrient uptake, photosynthesis, and overall plant metabolism, ultimately reducing plant productivity (Ahmad et al., 2021).

Manual visual inspection, traditional poor management practices and reactive pesticide application lead to delayed in disease identification. As infection systemically increase, symptoms become appear with limiting chemical intervention. (Khan et al., 2019). Additionally, poor farmer training and awareness of early disease indicators further promote delays in treatment and economic losses (Zafar et al., 2020).

Delays in disease detection found decrease in plant biomass and fruit yield in infected plants which showed similar trends with Sharma et al. (2018). If early-stage infections remain untreated, then rapidly intensified and severe malfunction in physiological processes in family solanaceae reported by Mehta and Singh (2020).

These challenges can be hinder by learning modern and rapid disease evaluation tools which facilitate authentic and early detection like hyperspectral imaging, machine learning-based diagnostic systems, and PCR-based pathogen identification (Patel et al., 2022). Implementation of farmers training, empowering knowledge and access, field monitoring and responsible use of agrochemicals are equally important and farmers may enhance their capacity to respond to plant health threats effectively and sustainability (Iqbal et al., 2022).

6. Conclusion

Recent study demonstrates the negative impacts of pathogen infection on plant health and vigor. When pathogen infect the plant, a gradual increase was observed in DI and DS with passage of time and ultimately significant decrease in morphological parameters of plant. It means poor management practices marked negative impacts on physiological health of plant and slowly infection proceed progressively which lead to yield loss of tomato. Traditional disease management practices not enough to overcome infection caused by pathogen attack and need to early detection and intervention. As compared to literature, it has been found that if pathogen attack not treated well or delayed then it leads to enhance DS and ultimately economic losses. Modern technologies adoption for timely disease identification methods and assessment tools are only way to overcome these challenges. Besides this, targeted training programs for farmers to improve awareness and suitable modern disease detection methods are need of hour for sustainable management practices. So, Scientific knowledge, accurate early disease detection methods and improved farmers training is only way to crop protection and overcome tomato yield loss.

References:

Ahmad, M., Rehman, S., & Gul, R. (2021). *Impact of plant pathogens on tomato productivity: A case study*. Journal of Agricultural Research, 59(2), 120–128.

de Rodriguez, D. J., Gaytán-Sánchez, N. A., Rodríguez-García, R., Hernández-Castillo, F. D., Díaz-Jiménez, L., Villarreal-Quintanilla, J. A., Flores-López, M. L., Carrillo-Lomelí, D. A., Peña-Ramos, F. M. (2019): *Antifungal activity of Juglans spp. and Carya sp. ethanol extracts against Fusarium oxysporum on tomato under greenhouse conditions*. – Industrial Crops and Products 138: 111442.

Iqbal, N., Aslam, M., & Farooq, S. (2023). *Training needs assessment for integrated pest management in tomato farming*. Journal of Rural Studies, 94, 102–110.

Jones, J. B., Jones, J. P., Stall, R. E., & Zitter, T. A. (2014). *Compendium of Tomato* Diseases and Pests. APS Press.

Khan, A., Tariq, M., & Saeed, Q. (2019). *Challenges in managing tomato blight in smallholder systems*. Plant Protection Journal, 45(1), 34–41.

Kumar, S., Gupta, R., & Sharma, P. (2019). *Effects of pathogen infection on tomato plant growth and productivity*. Journal of Plant Pathology, 101(3), 567-574.

Kurabachew, H., Stahl, F., Wydra, K. (2013): *Global gene expression of rhizobacteria silicon mediated induced systemic resistance in tomato (Solanum lycopersicum) against Ralstonia solanacearum*. – Physiological and Molecular Plant Pathology 84: 44-52.

Mehta, A., & Singh, B. (2020). *Physiological response of tomato plants to Fusarium wilt under field conditions*. Journal of Horticultural Science, 55(2), 210–215.

Patel, R., Das, P., & Choudhary, H. (2022). *AI-driven diagnostics for tomato disease detection*. Precision Agriculture, 23(1), 75–90.

Sharma, P., Ali, S., & Kumar, V. (2018). *Fungal diseases of tomato and their impact on yield*. Indian Phytopathology, 71(3), 387–392.

Silva, B. N., Picanço, B. B., Martins, S. C., & Rodrigues, F. A. (2023). *Impairment of the photorespiratory pathway on tomato leaves during the infection process of Septoria lycopersici*. Physiological and Molecular Plant Pathology, 125, 102020.

Smith, A., & Brown, K. (2017). *Challenges in disease management among smallholder farmers*. Agricultural Systems, 153, 93-101.

Zafar, M., Latif, A., & Shahid, R. (2020). *Farmer perceptions and management of tomato diseases in Punjab, Pakistan*. Agricultural Extension Review, 12(4), 50–58.

Submission: March 20, 2024, Revised: May 10, 2025

Accepted: May 30, 2025

Published Online: December 22, 2025