



The Incidence and Severity of Pathogenic Fungal Diseases on Tomato Plants in Irasa Farm Cluster, Ado-Ekiti, Nigeria

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

Tomato (*Solanum lycopersicum* L.) is a globally significant crop. Today, tomatoes are valued for their taste, color, flavor, and nutritional content, making them a popular choice for both fresh consumption and processing. However, its production is severely threatened by fungal diseases, leading to substantial yield losses. This study evaluated the incidence and severity of major fungal diseases affecting tomato plants. The study was carried out in the Irasa Farm Cluster, Ado-Ekiti, Nigeria, through a survey across eight farms using a modified disease severity scale. A comprehensive survey was conducted utilizing a randomized sampling approach for data collection. On each farm, a random sample of 30 tomato plants was chosen, following a diagonal

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pattern, and assessed for disease incidence and severity. The collected data on disease incidence and severity were subjected to statistical analysis, and the results were summarized as mean percentage values for each farm. The survey revealed the prevalence of early blight (*Alternaria solani*) (50.6%), Fusarium wilt (*Fusarium oxysporum*) (Farm E - 53.83% and Farm A- 40.32%), Septoria rot (*Septoria lycopersici*), powdery mildew (*Leveillula taurica*), and Sclerotium rot (*Sclerotium rolfsii*) at the study location. Fusarium wilt had the highest incidence, while early blight was the most severe. Sclerotium rot and Septoria rot incidence and severity were minimal at the study site. There is a need for farmer education and integrated disease management approaches in managing these fungal diseases for sustainable food production and food security. The introduction of cultivars resistant to Fusarium wilt and early blight should be introduced to enhance tomato production sustainability. Effective management of fungal diseases affecting tomatoes requires a multi-faceted approach. Recommended practices include crop rotation, sanitation, timely fungicide application, seed treatment, and nursery bed treatment.

Keywords: Incidence; severity; tomato; fungal pathogens; farmer education; sustainable food production.

1. INTRODUCTION

Tomatoes (*Solanum lycopersicum* L.) are one of the most widely consumed vegetables globally, with a rich history dating back to South America, possibly Peru and Ecuador, but were first domesticated in Mexico (Benton, 2007). Today, tomatoes are valued for their taste, color, flavor, and nutritional content, making them a popular choice for both fresh consumption and processing. According to Garrido and Luque-Romero (2014), tomatoes are grown practically in every country of the world in greenhouses, net houses, and outdoor fields. The crop can be divided into two categories: fresh market tomatoes and processing tomatoes. Tomato fruits, aside from being tasty, are healthy, being a good source of vitamins A and C, which are essential for maintaining a healthy immune system and overall well-being (Maria et al., 2014).

The global production of tomatoes has been steadily increasing over the years, with the Food and Agriculture Organization (FAO) estimating an annual production of over 180 million metric tons (FAOSTAT, 2020). The leading producers of tomatoes include China, India, the United States, and countries in the European Union. According to FAO (2020), the trade of tomatoes both fresh and processed, plays a significant role in the global economy, with major exporting countries like Mexico, Spain, and the U.S. supplying fresh tomatoes, while Italy, China, and the U.S. are key exporters of processed tomato products such as sauces, paste, and juice. In 2020, the global trade in tomatoes and tomato products was valued at billions of dollars, creating significant economic

value, supporting national economies, and driving job creation in both agriculture and other industries. In Nigeria, *S. lycopersicum* takes about 18% of the mean intake of vegetables every day, this makes it an essential food crop to a typical Nigerian. In many areas of the globe, tomatoes have become a significant industrial crop due to their financial significance and dietary value to human nutrition and human health (Ewekeye & Odebode, 2021; Danmaigoro et al., 2024).

Despite the increasing production of tomatoes, the crop is susceptible to various diseases, particularly those caused by fungal pathogens. According to Kharde et al. (2010), fungi are an important group of microorganisms responsible for various diseases of plants and cause a considerable loss in yield. Some of the most common fungal diseases affecting tomatoes include leaf blights, leaf spots, mildews, rots, and wilt diseases. These diseases can be caused by various species of fungi, including *Alternaria*, *Septoria*, *Phytophthora*, and *Fusarium*. As reported by Plant-disease-guide (2020), about 85% of plant diseases are caused by fungal pathogens, which can lead to 50-80% tomato fruit losses if not properly managed. During infection, pathogens adopt various strategies, including delivering effector molecules or virulence factors into the host plant so that the host plant's defense becomes weak. The defense mechanism is also activated on the host plant side, and biochemical activities occur. As a result, if the pathogens cannot grow on the host tissue, a resistance response occurs. In contrast, disease development occurs if they can establish relationships and grow successfully (Panthee et al., 2024).

Tomato plants are mostly vulnerable to biotic stresses like fungi, bacteria, viruses and nematodes and environmental factors like temperature, sunlight, malnutrition, etc.) (Ma et al., 2023). The management of fungal diseases in tomatoes is crucial to prevent losses and ensure sustainable production. According to Merrill et al. (1997), some species of fungus produce mycotoxins that are very toxic to humans. Therefore, integrated disease management approaches are necessary, including the use of resistant cultivars, crop rotation, and cultural practices that promote healthy plant growth. Additionally, the use of fungicides and other chemical controls can be effective in managing fungal diseases, but their use should be judicious and based on sound ecological principles to minimize environmental impacts. As reported by NARC (2010), more than 40 tomato diseases have been studied in Nepal, highlighting the need for continued research and development of effective management strategies. This study focuses on evaluating the incidence and severity of pathogenic fungal diseases on tomato plants to identify strategies that can mitigate the severity of these diseases and enhance tomato production. The study will inform farmers and policymakers to adopt effective fungal management strategies.

2. MATERIALS AND METHODS

2.1 The Study Area

The study was carried out in the Irasa Farm Cluster, Ado-Ekiti, located in Ekiti State, Nigeria. Ekiti State, situated in southwestern Nigeria, boasts a rich cultural heritage, a diverse population, and fertile agricultural land. Established in 1996, the state capital is Ado-Ekiti. With a predominantly rural landscape, Ekiti State focuses heavily on agriculture, producing key crops like cocoa, cassava, maize, rice, and pineapples, as well as engaging in livestock farming. The state is also renowned for its esteemed educational institutions, solidifying its reputation as a hub for learning in Nigeria. Ekiti's diverse landscapes, featuring hills, forests, and

rivers, make it an attractive destination for tourism. Furthermore, the state is committed to economic growth, implementing initiatives to enhance agriculture, infrastructure, and human capital development.

2.2 Documentation of Incidence and Severity of Fungal Diseases of Tomatoes

A comprehensive survey was conducted across eight tomato farms (designated A-H) at Irasa Farm Cluster, utilizing a randomized sampling approach for data collection. The selected farms were strategically located 0.8-1 km apart. On each farm, a random sample of 30 tomato plants was chosen, following a diagonal pattern, and assessed for disease incidence and severity. A modified disease severity scale, developed by CSIR Crops Research Institute (2011), was employed to evaluate the disease symptoms, categorizing them into six distinct levels:

1. No visible disease symptoms on the tomato plant.
2. Disease symptoms affecting 5-25% of the total leaf area.
3. Disease symptoms covering 25-50% of the total leaf area.
4. Disease symptoms affecting 50-75% of the total leaf area.
5. Disease symptoms covering 75-100% of the total leaf area, resulting in complete plant death and no yield.
6. (Implicitly included in level 5, as no additional description is provided)

This assessment enabled the researchers to quantify the impact of diseases on the surveyed tomato plants accurately.

2.3 Formula to Calculate the Disease Incidence and Severity

Final disease incidence and severity were calculated using the formula recommended by CSIR- Crops Research Institute (2014) as below:

$$\text{Disease incidence: } \frac{\text{No. of infected plants}}{\text{Total plants Scored}} \times 100$$

$$\text{Disease severity: } \frac{(\text{Summation of plant scored for each rating} \times \text{the rating value})}{\text{Total plant score per farm}} \times 100$$

2.4 Presentation of Data

The collected data on disease incidence and severity were subjected to statistical analysis, and the results were summarized as mean percentage values for each farm. These findings were presented in tabular form for clarity. Additionally, the fungal species isolated from the infected tomato plants were carefully documented, providing valuable insights into the diversity of fungal pathogens affecting tomato crops in the study area.

3. RESULTS

3.1 Major Fungal Diseases of Tomato Identified in the studied Farms

A thorough examination of the sampled tomato plants in the study area revealed the presence of five distinct fungal diseases. These diseases included Early blight, Fusarium wilt, Septoria rot, powdery mildew, and Sclerotium rot, each exhibiting unique symptom expressions. The severity of these diseases was carefully assessed and scored directly from the farmers' fields, providing a comprehensive understanding of the disease dynamics in the study area.

3.2 Incidence of Major Fungal Diseases of Tomato Plants in Irasa Farm Cluster

Table 1 presents the incidence of major fungal diseases affecting tomato plants in the Irasa Farm Cluster. A notable variation in disease incidence was observed across the farms. Early Blight was most prevalent in Farm A, with a significant incidence rate of 50.6%, indicating a major disease pressure on this farm. In contrast, Farm H showed a remarkably low incidence rate of 4.2%. Fusarium wilt was found to be a significant concern in Farm E and Farm A, with incidence rates of 53.83% and 40.32%,

respectively. However, the disease was relatively less severe on other farms, such as Farm B and Farm H.

Septoria rot exhibited varying levels of infection across the farms, with Farm C and Farm D showing the highest incidence rates of 20.34% and 14.64%, respectively. Conversely, Farms F, G, and H demonstrated minimal to no occurrence of this disease, suggesting effective disease management strategies or environmental conditions that limited its spread. Powdery mildew was another common issue, particularly in Farm D and Farm F, with incidence rates of 21.7% and 15%, respectively. However, Farm C and Farm H showed minimal to no occurrence of this disease, which may be attributed to effective preventive measures or less conducive environmental conditions.

Sclerotium rot was found to be a problem across multiple farms, with Farm A and Farm D showing the highest incidence rates of 20% and 18.42%, respectively. However, the disease was absent in Farm C, Farm F, and Farm H, suggesting that these farms might have better soil and crop management practices that prevent the disease. Overall, the results highlight the need for targeted disease management strategies and improved crop management practices to mitigate the impact of these fungal diseases on tomato production in the Irasa Farm Cluster.

3.3 Severity of Fungal Diseases of Tomato Plants in Irasa Farm Cluster

Table 2 presents the severity of fungal diseases affecting tomato plants in the Irasa Farm Cluster. The results indicate that Early Blight is the most widespread and severe fungal infection across the farms, with all farms except Farm H exhibiting moderate to high severity levels, ranging from 2.0 to 2.5. Farm H, however, showed the lowest severity level of 0.5.

Table 1. Incidence of major fungal diseases of tomato plants in Irasa Farm Cluster

Farms	Early Blight	Fusarium wilt	Septoria rot	Powdery Mildew	Sclerotium rot
A	50.6	40.32	10.1	12.4	20
B	40.3	10.45	10.5	04.6	10
C	30.2	35.5	20.34	0.0	0.0
D	21.8	30.9	14.64	21.7	18.42
E	20.4	53.83	18.93	0	18.3
F	18.32	20.93	0.0	15	0.0
G	36.0	42.59	0.0	09	10
H	04.2	10.5	0.0	00	0.0

Table 2. Severity of fungal diseases of tomato plants in Irasa Farm Cluster

Farms	Early Blight	Fusarium wilt	Septoria rot	Powdery Mildew	Sclerotium rot
A	2.5	2	1	1	1
B	2	1	0.5	0.5	1
C	2.1	2.4	1	0	0
D	2	1.8	2	1	1
E	2	2.4	1.5	0	1
F	2	1.6	0	0.5	0
G	2.3	1	0	0.5	0.5
H	0.5	2.6	0	0	0

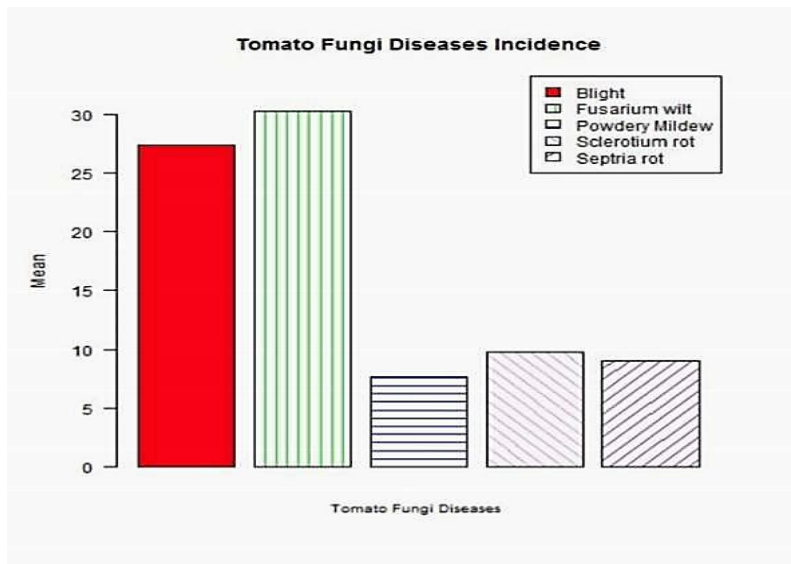


Fig. 1. Mean tomato pathogenic fungal disease incidence at Irasa Farm Cluster

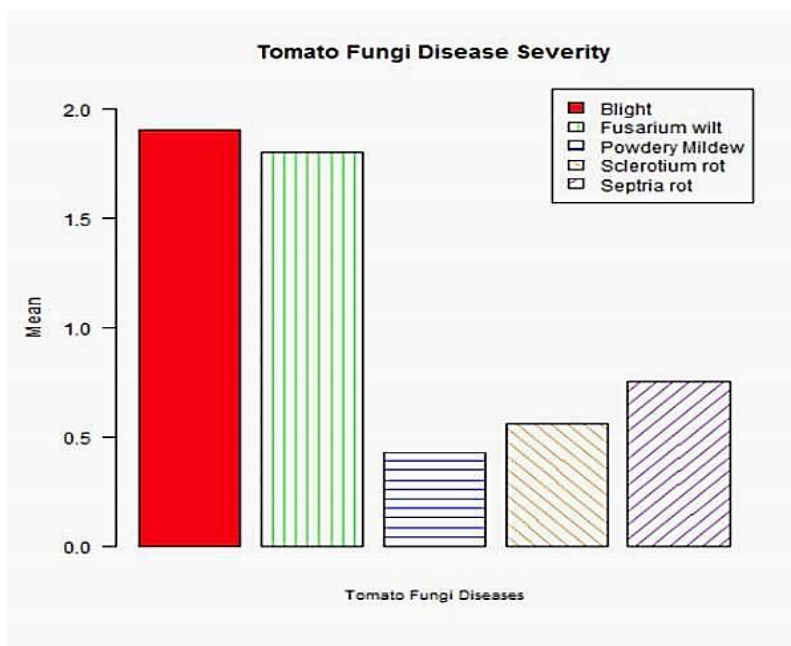


Fig. 2. Mean tomato pathogenic fungal disease severity at Irasa Farm Cluster

Fusarium Wilt is another significant disease, causing wilting and yellowing of tomato plants, with varying severity levels among the farms. Farm H showed the highest severity level of 2.6, significantly higher than the other farms. Farms E and C also reported relatively high severity levels of 2.4, while the rest of the farms showed moderate to lower levels of Fusarium Wilt, ranging from 1.0 to 2.0. Notably, Farm B and G showed the lowest severity level of 1.0, indicating better control or resistance to the disease.

Septoria rot showed relatively low severity levels across all farms, with most farms reporting a severity level of less than 1, except for Farm D, which reported a severity level of 2.0. This suggests that Septoria rot, while present, is not a major issue in most of the farms in the Irasa Cluster. Powdery Mildew was found to be the least severe of the diseases listed, with most farms reporting a severity level of either 0 or below 1. The highest severity level was reported in Farms A and D, with a severity level of 1.0. Sclerotium Rot showed variability across farms, with Farms A, B, D, and E exhibiting mild to moderate severity levels of 1.0, indicating that the disease is present but not widespread. Farms F, G, and H reported the lowest severity levels of 0, indicating minimal issues with Sclerotium Rot.

3.4 Mean Tomato Pathogenic Fungal Disease Incidence at Irasa Farm Cluster

Fig. 1 illustrates the mean incidence of tomato pathogenic fungal diseases at the Irasa Farm Cluster. A notable variation in disease incidence was observed among the five fungal pathogens, with statistically significant differences detected. The graph reveals that Fusarium wilt had the highest disease incidence, closely followed by Early blight. Sclerotium rot and Septoria rot also showed moderate disease incidence, while powdery mildew had the lowest incidence among the five fungal diseases.

3.5 Mean Tomato Pathogenic Fungal Disease Severity at Irasa Farm Cluster

Fig. 2 illustrates the mean severity of tomato pathogenic fungal diseases at the Irasa Farm Cluster. The graph reveals a notable ranking of disease severity among the five fungal pathogens. Early blight exhibited the highest disease severity, followed closely by Fusarium wilt. Septoria rot, Sclerotium rot, and powdery mildew showed progressively lower disease

severity, with powdery mildew having the lowest severity among the five fungal diseases.

4. DISCUSSION

Agriculture plays a vital role in sustaining the livelihoods of millions of people worldwide, providing essential food and nutrition. However, the agricultural sector is perpetually threatened by various pathogens, including fungal diseases, which can significantly reduce crop yields and compromise food security. Tomato crops, in particular, are susceptible to a range of fungal diseases, including Early blight, Fusarium wilt, Septoria rot, powdery mildew, and Sclerotium rot. These diseases can cause substantial yield losses and economic hardship for farmers, underscoring the need for effective disease management strategies. According to Agrios (2005), disease incidence and severity can significantly reduce yields, resulting in losses for farmers.

Research has shown that the incidence and severity of fungal diseases affecting tomato crops can vary significantly depending on factors such as crop stage, environmental conditions, and agricultural practices. For instance, studies conducted in Nigeria by Adebajo et al. (2020) found that the incidence of fungal diseases tends to increase as tomato crops mature, with the highest disease severity observed in plants with mixed infections. Furthermore, research by Khan et al. (2020) revealed that fungal diseases tend to affect tomato plants more severely during the flowering and fruiting stages, when increased moisture and humidity create an environment conducive to fungal growth and development. By understanding the complex interplay between these factors and fungal disease dynamics, farmers and agricultural practitioners can develop targeted management strategies to minimize yield losses and ensure a healthy, productive crop.

The economic implications of fungal diseases affecting tomato crops cannot be overstated. In addition to reducing crop yields, these diseases can also compromise fruit quality, leading to significant economic losses for farmers. Moreover, the extensive application of fungicides can have unintended environmental consequences, highlighting the need for integrated disease management approaches that balance economic and environmental considerations. By adopting a holistic approach to disease management, farmers

and agricultural practitioners can minimize the impact of fungal diseases on tomato crops, ensuring a sustainable and productive agricultural sector.

5. CONCLUSION

The study's findings highlighted the significant impact of fungal diseases on tomato yields in the Irasa Farm Cluster, Ado-Ekiti, which poses a substantial threat to tomato cultivation in the region. The data revealed that Early Blight and Fusarium Wilt are the most prevalent and destructive fungal infections in the cluster, with Early Blight exhibiting the highest severity across most farms. In contrast, Powdery Mildew and Sclerotium Rot were found to have a relatively minimal impact on the farms. The observed variability in disease severity between farms may be attributed to differences in farm management practices, environmental conditions, plant varieties, or resistance to specific fungal pathogens.

To mitigate the severity of these diseases, particularly in farms with higher infection levels, more targeted management strategies are necessary. Such approaches may include crop rotation, judicious fungicide application, or the use of resistant varieties. By adopting these strategies, farmers can reduce the impact of fungal diseases on their tomato crops, thereby enhancing yield stability and sustainability in the Irasa Farm Cluster.

6. RECOMMENDATIONS

Effective management of fungal diseases affecting tomatoes requires a multi-faceted approach. Recommended practices include crop rotation, sanitation, timely fungicide application, seed treatment, and nursery bed treatment. To promote awareness and adoption of these strategies, sensitization programs should be conducted for stakeholders in the tomato industry, particularly farmers and agricultural extension agents.

Moreover, there is a need for further research to be conducted during both major and minor seasons, employing an integrated pest and disease management approach. This would provide valuable insights and information for the development of more effective management strategies for fungal diseases affecting tomatoes in the study districts. By adopting a comprehensive and integrated approach, farmers and agricultural practitioners can better manage

fungal diseases, reducing their impact on tomato crops and enhancing overall productivity.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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