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INCIDENCE, ETIOLOGY AND EPIDEMIOLOGICAL DYNAMICS OF GUAVA FRUIT ROT DISEASE UNDER SUBTROPICAL CONDITIONS OF BIHAR

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ABSTRACT

Guava (Psidium guajava L.) is an important fruit crop in Bihar, but its production is severely affected by fruit rot disease, leading to significant post-harvest losses. The present study investigated the incidence, causes, and epidemiological behavior of guava fruit rot in major districts including Vaishali, Bhagalpur, Gaya, and Nalanda. The results showed that the disease was widespread, with an average incidence of 35.03%. A clear seasonal effect was observed, with higher incidence during the monsoon (42.80%) compared to winter (21.50%). Laboratory analysis revealed that multiple fungal pathogens were involved, with *Colletotrichum gloeosporioides* as the dominant species, followed by *Fusarium*, *Alternaria*, and *Aspergillus*. Environmental factors such as high humidity and temperature strongly influenced disease development. The study also found that infection begins in the field but intensifies after harvest. Overall, fruit root causes 25–40% loss, highlighting the need for improved management practices and farmer awareness.

1. Introduction

1.1 Importance of Guava

Guava (*Psidium guajava L.*) is one of the most important fruit crops grown in tropical and subtropical regions. It is widely cultivated because it can grow easily in different types of soil and climatic conditions. Compared to many other fruit crops, guava requires less care and investment, which makes it suitable for small and marginal farmers. From a nutritional point of view, guava is highly valuable. It contains a large amount of vitamin C, which is much higher than many common fruits. It also provides dietary fiber, minerals like potassium and calcium, and important antioxidants. Because of this, guava helps in improving immunity, digestion, and general health. It is especially useful in rural areas where people may not have access to expensive fruits or supplements. Regular consumption of guava can help reduce problems like anemia, weak immunity, and digestive disorders. In Bihar, guava cultivation has become very important over time. The state has suitable conditions such as fertile alluvial soil, adequate water availability, and a favorable climate. Districts like Vaishali, Bhagalpur, Nalanda, and Gaya are well known for guava production. For many farmers in these areas, guava is a reliable source of income. Once the orchard is established, it gives fruits for several years and provides regular seasonal earnings. Guava cultivation also creates employment in rural areas. Activities such as harvesting, grading, transport, and local selling involve many people, including women and small traders. In addition, small processing activities like making juice, jelly, and sweets also depend on guava.

1.2 Statement of Problem

In Bihar, most farmers do not have access to cold storage, proper packaging, or fast transportation. Because of this, fruits start rotting within a few days after harvesting. As a result, farmers are forced to sell their produce quickly, often at low prices. If the fruits are already infected, they may not be sold at all. This leads to direct income loss. In many cases, farmers cannot recover even their production costs. This situation becomes more serious for small and marginal farmers who depend heavily on guava as a cash crop. Another issue is that middlemen take advantage of this situation. Since farmers cannot store their produce, they accept whatever price is offered. Thus, fruit rot not only causes physical loss of produce but also reduces farmers' bargaining power in the market.

1.3 Nature of Disease

Guava fruit rot is a complex disease that develops in more than one stage. In many cases, the infection begins in the field when the fruit is still on the tree. However, the symptoms may not be clearly visible at that time. After harvesting, when fruits are stored or transported, the disease develops rapidly and becomes more severe. This means that fruit rot

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is both a pre-harvest and post-harvest disease. The pathogens enter the fruit through small injuries, natural openings, or weak points on the fruit surface. Once inside, they grow quickly, especially under warm and humid conditions. The disease is mainly caused by fungal pathogens. Important fungi associated with guava fruit rot include *Colletotrichum gloeosporioides*, *Fusarium spp.*, *Alternaria alternata*, and *Aspergillus niger*. These fungi are commonly present in the environment and can easily infect fruits when conditions are favorable. The symptoms of fruit rot start with small brown or black spots on the fruit surface. These spots gradually increase in size and become sunken. As the disease progresses, the fruit becomes soft and watery. In the final stage, the fruit gives a bad smell and becomes completely unfit for consumption. The spread of the disease is strongly influenced by environmental conditions. High temperature, high humidity, and rainfall create favorable conditions for fungal growth. Poor orchard management, lack of pruning, and improper handling of fruits also increase the chances of infection.

1.4 Research Gap

There is a lack of detailed studies that explain how the disease behaves under Bihar's specific climate. For example, information on seasonal variation, district-wise incidence, and environmental influence is not properly documented. Without this information, it becomes difficult to understand the actual severity and pattern of the disease. Another important gap is related to pathogen identification. Although different fungi are known to cause fruit rot, their relative importance and frequency in Bihar are not clearly studied. It is not known which pathogen is most dominant and under what conditions. Due to these gaps, farmers do not get proper guidance for disease management. Most of them rely on traditional practices or chemical fungicides without proper knowledge.

2. Research Objectives (RO)

The present study has been carried out with the following objectives:
RO_1: To measure the incidence of guava fruit rot disease in different parts of Bihar
RO_2: To identify the major fungal pathogens responsible for the disease
RO_3: To study the effect of environmental factors such as temperature, humidity, and rainfall
RO_4: To analyze the epidemiological pattern and development of the disease

3. Materials and Methods

The study was conducted in major guava-growing districts of Bihar (Vaishali, Bhagalpur, Gaya, and Nalanda) to investigate fruit rot disease. A random survey of 10–15 orchards was carried out during the monsoon and winter seasons, and 200–300 fruits were examined for disease incidence. Infected fruits were identified based on visible symptoms, and disease incidence was calculated as a percentage. Pathogens were isolated on Potato Dextrose Agar (PDA) after surface sterilization and identified using colony morphology and

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microscopic characteristics. Environmental data (temperature, humidity, and rainfall) were recorded. Data were analyzed using percentage, mean, correlation analysis, and presented through tables and graphs using Microsoft Excel and SPSS.

$$\text{Disease Incidence (\%)} = \frac{\text{Number of infected fruits}}{\text{Total number of fruits observed}} \times 100$$

4. Results

4.1 District-wise incidence of guava fruit rot disease

The survey revealed that guava fruit rot disease was prevalent in all selected districts of Bihar, indicating its widespread occurrence. The highest disease incidence was recorded in Vaishali (36.67%), followed by Nalanda (36.36%) and Bhagalpur (36.00%), while Gaya showed the lowest incidence (31.11%). The overall mean incidence was 35.03%, indicating that more than one-third of the fruits were infected. These findings demonstrate that fruit rot is a major constraint to guava production and marketing in Bihar. Variations among districts may be associated with differences in humidity, orchard management, canopy density, harvesting practices, and local environmental conditions.

Table 1. District-wise incidence of guava fruit rot disease

District	Total fruits observed	Infected fruits	Incidence (%)
Vaishali	60	22	36.67
Bhagalpur	50	18	36.00
Gaya	45	14	31.11
Nalanda	55	20	36.36
Mean			**35.03**

Source: Primary Data

4.2 Seasonal variation in fruit rot incidence

Season had a strong effect on disease development. The comparison between monsoon and winter samples showed that fruit rot was much more severe during the monsoon period. The incidence of guava fruit rot was significantly higher during the monsoon (42.80%) than in winter (21.50 High humidity, rainfall, and warm temperatures during the monsoon favor fungal growth and disease spread. Although lower in winter, the disease remained significant, highlighting the need for effective disease management throughout the year.%).

Table 2. Seasonal incidence of guava fruit rot disease

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Season	Incidence (%)
Monsoon	42.80
Winter	21.50

Source: Author's work

4.3 Symptom development of fruit rot disease

The study revealed a clear progression of guava fruit rot symptoms through three distinct stages. In the **early stage**, small brown spots appeared on the fruit surface, making infection difficult to detect. During the **middle stage**, these spots enlarged into sunken lesions, causing visible deterioration in fruit quality. In the **advanced stage**, infected tissues became soft, water-soaked, and extensively decayed, often accompanied by an unpleasant odour. At this stage, fruits were unsuitable for storage, transportation, or marketing.

Table 3. Symptom progression in guava fruit rot disease

Disease stage	Symptoms observed
Early stage	Small brown spots on fruit surface
Middle stage	Spots enlarge and become sunken lesions
Advanced stage	Soft rot, tissue breakdown, foul smell

Source: Author's work

4.4 Identification of causal pathogens

Each pathogen contributed to different symptoms, ranging from surface lesions to extensive tissue decay and storage spoilage. The coexistence of multiple fungi demonstrates that guava fruit rot is a multifactorial disease. Therefore, effective disease control requires a comprehensive management approach that addresses the entire pathogen complex rather than a single causal organism.

Table 4. Pathogens identified from infected guava fruits

Pathogen	Associated disease condition
Colletotrichum gloeosporioides	Anthracnose / fruit rot
Fusarium spp.	Rot
Alternaria alternata	Spot and rot
Aspergillus niger	Storage rot

Source: Author's work

4.5 Frequency of isolated pathogens

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The frequency of fungal isolates varied considerably among the pathogens identified. **Colletotrichum** was the most prevalent fungus, accounting for **40.50%** of the total isolates, followed by **Fusarium** (25.20%), **Alternaria** (18.30%), and **Aspergillus** (16.00%). The predominance of *Colletotrichum* indicates that it is the principal pathogen responsible for guava fruit rot in the study area. However, the combined occurrence of the other fungi also contributes substantially to disease severity. These findings demonstrate that guava fruit rot is a complex disease involving multiple pathogens and emphasize the importance of integrated management practices targeting the entire fungal community rather than a single species.

Table 5. Frequency of different pathogens isolated from infected fruits

Pathogen	Frequency (%)
Colletotrichum	40.50
Fusarium	25.20
Alternaria	18.30
Aspergillus	16.00

Source: Author's work

The frequency analysis showed clear differences in the occurrence of fungal pathogens associated with guava fruit rot. **Colletotrichum** was the most frequently isolated pathogen (40.50%), followed by **Fusarium** (25.20%), **Alternaria** (18.30%), and **Aspergillus** (16.00%). The predominance of *Colletotrichum* indicates that it is the principal causal organism responsible for fruit rot in the study area. However, the substantial occurrence of the remaining fungi demonstrates that disease development results from the combined activity of multiple pathogens. This distribution highlights the need for integrated disease management practices that effectively control both the dominant pathogen and the associated fungal species

4.6 Role of environmental factors in disease development

The study demonstrated that climatic conditions significantly influenced the development of guava fruit rot. Disease incidence increased under temperatures ranging from **25–32°C**, which are common during the fruiting season in Bihar. **Relative humidity (75–90%)** was identified as the most critical factor, as it created favourable conditions for fungal growth, spore germination, and lesion expansion. Frequent rainfall further enhanced disease spread by maintaining surface moisture and facilitating spore dispersal through rain splash. Wet harvesting conditions and prolonged moisture after rainfall also increased post-harvest infection. These findings confirm that warm, humid weather strongly promotes fruit rot and increases disease severity during the monsoon season

Table 6. Major environmental factors associated with disease development

Parameter	Observed range / condition	Effect on disease

Temperature	25–32°C	Favorable for fungal growth
Relative humidity	75–90%	Highly favorable
Rainfall	High	Supports spore spread and infection

Source: Author's work

4.7 Relationship between climate and disease incidence

The correlation between humidity and disease incidence was 0.82, which indicates a strong positive relationship. This means that when humidity increased, disease incidence also increased sharply. The correlation between temperature and disease incidence was 0.65**,** which also shows a positive relationship, though less strong than humidity. This suggests that temperature supports disease development, but humidity has a greater influence in the present study. These values confirm that climate is not merely a background factor. It is directly connected with disease expression and spread. Therefore, any disease forecasting or management plan for guava fruit rot in Bihar must give special importance to humidity and seasonal weather conditions.

Table 7. Correlation between environmental factors and disease incidence

Factor	Correlation coefficient (r)
Humidity vs disease incidence	0.82
Temperature vs disease incidence	0.65

Source: Author's work

4.8 Pre-harvest and post-harvest infection pattern

The study showed that fruit rot infection was moderate in the field but increased considerably during storage and transportation. This indicates that fungal infection often begins before harvest and progresses rapidly under favourable post-harvest conditions such as mechanical injuries, high moisture, poor ventilation, and delayed marketing. Consequently, fruits appearing healthy at harvest may deteriorate before reaching consumers. The estimated economic loss ranged from **25–40%**, significantly reducing both the quantity and quality of marketable fruits. Limited cold storage facilities and inadequate post-harvest management further increase these losses, making fruit rot a major economic challenge for guava growers in Bihar.

Table 8. Relative infection level at pre-harvest and post-harvest stage

Stage	Infection level

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Field (pre-harvest)	Moderate
Storage / transport (post-harvest)	High

Source: Author's work

5. Discussion

The findings indicate that guava fruit rot is a major fungal disease in Bihar, with Colletotrichum identified as the multiple pathogens suggest most prevalent pathogen, followed by Fusarium**,** Alternaria, and Aspergillus**.** The occurrens that the disease requires an integrated management approach rather than control measures targeting a single fungus. Disease incidence was markedly higher during the monsoon, demonstrating the significant influence of high humidity and rainfall on fungal infection. These results are consistent with earlier reports on guava fruit rot. In Bihar, poor orchard sanitation, inadequate storage facilities, and improper post-harvest handling further increase disease severity and economic losses.

6. Conclusion

The study concludes that guava fruit rot is a major disease affecting guava production in Bihar, with an average incidence of about 35%. Colletotrichum was identified as the predominant pathogen, followed by Fusarium**,** Alternaria**,** and Aspergillus. Disease incidence was highest during the monsoon, confirming the strong influence of humidity and rainfall on fungal development. Infection begins in the field and intensifies during post-harvest handling due to poor storage and transportation conditions. The disease causes substantial economic losses to farmers. Improving orchard sanitation, adopting proper post-harvest management, and increasing farmer awareness are essential for reducing fruit rot and enhancing guava productivity.

7. Suggestions

Based on the findings of the study, the following suggestions are recommended to reduce guava fruit rot disease in Bihar:

- Practice regular pruning, proper plant spacing, and orchard sanitation to improve air circulation and reduce disease spread.
- Remove and destroy infected fruits and plant debris to eliminate sources of fungal infection.
- Apply recommended fungicides judiciously and promote eco-friendly methods such as ***Trichoderma*** spp. and neem-based products.
- Harvest fruits carefully, separate infected fruits, and use clean packaging to minimize post-harvest losses.
- Store fruits under cool and dry conditions and improve cold storage and transportation facilities.

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- Conduct farmer training programmes on disease identification, integrated disease management, and improved orchard practices.
- Encourage further research on disease-resistant guava varieties and sustainable management strategies.

Guava fruit rot disease can be effectively managed only through an integrated approach that includes proper orchard management, timely disease control, improved post-harvest practices, and farmer awareness.

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