AGROFARM ISSN No. 2988-1803
Vol 5. No. 1 :1-6, Mei 2026 https://ejournal.unmas.ac.id/index.php/agrofarm
Doi: https://doi.org/10.36733/agrofarm.v5i1.13132

Disease Intensity and Incidence of Black Sigatoka on Banana (*Musa paradisiaca*) in Karang Bendo, Banguntapan District, Bantul Regency, Special Region of Yogyakarta

Intensitas dan Insidensi Penyakit Black Sigatoka pada Tanaman Pisang (Musa paradisiaca) di Karang Bendo, Kecamatan Banguntapan, Bantul, Daerah Istimewa Yogyakarta

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Abstract

Banana (*Musa paradisiaca*) is one of the most important commodities for food security and local economy, particularly in Indonesia. However, banana productivity is threatened by several major biotic stress factors, including insect pests and fungal diseases. The present study was conducted in Karang Bendo, Banguntapan District, Bantul Regency, aiming to identify the presence and impact of major banana pests and diseases, namely Black Sigatoka disease. Field surveys were carried out using the Simple Random Sampling method, with observations on symptoms of infestation and infection on leaves, pseudostems, and corms. Data analysis was performed using descriptive statistics and ANOVA to determine infestation intensity. The results showed that Black Sigatoka (*Pseudocercospora fijiensis*) resulted in leaf spotting, reduced fruit shelf life, and increased control costs. Overall, these pests and diseases significantly affect banana growth, yield, and plantation longevity. Integrated pest and disease management strategies based on accurate field identification are required to reduce production losses and support sustainable banana cultivation.

Keywords: Banana, Black Sigatoga, Field surveys, Phatogen

Introductions

Agriculture serves as a primary source of food for humanity and significantly impacts the economic stability of many countries. Agriculture remains the primary livelihood for many developing countries. Banana cultivation plays a crucial role in the global agro-industry due to its rich content of essential minerals such as calcium, manganese, potassium, magnesium, and iron. These nutrients make bananas a popular choice worldwide, often considered a quick energy booster. According to recent data from Wikipedia, approximately 15% of global banana production is exported to Western countries, highlighting the importance of bananas in international trade. India leads global production, contributing approximately 25.7%, followed by countries such as the Philippines, Ecuador, Indonesia, and Brazil, which together account for 20% of global banana production. The United States is the top importer, accounting for approximately 18% of global banana imports (Narayanan *et al*., 2022).

Indonesia is home to a diverse variety of bananas, including those suitable for immediate consumption, those requiring processing before consumption, seeded bananas, fiber-producing bananas, and ornamental banana plants commonly found in home gardens. Banana plants thrive throughout Indonesia, thriving in almost every region, whether cultivated in gardens or growing wild on roadsides. The Musa paradisiaca banana species is widely favored by all levels of society in Indonesia due to its accessibility, affordability, and nutritional benefits. Bananas are rich in essential nutrients such as vitamins A, B, and C, fiber, carbohydrates, and minerals, making them an important source of energy and health support. Some nutritionists even recommend bananas as a carbohydrate substitute for staple foods like rice. The fiber and vitamin content in this fruit contributes to improved metabolic function, antioxidants that help fight free radicals, and promotes a feeling of fullness for longer, thus supporting overall health (Budiyanto *et al*., 2018)

However, banana production faces significant threats from diseases and climate-related changes that can cause significant losses, sometimes wiping out entire harvests. Major diseases affecting bananas include black Sigatoka. These diseases cause severe damage to banana plants, with symptoms such as leaf spotting, wilting, and stunted growth, ultimately reducing yield and fruit quality. Furthermore, banana plant susceptibility to these pathogens is exacerbated by environmental stressors such as temperature fluctuations and increased rainfall, which are becoming more common due to climate change. Disease control efforts, development of resistant cultivars, and sustainable agricultural practices are critical to maintaining banana production, supporting the economies that depend on this crop, and maintaining global food security (Narayanan *et al*., 2022).

Despite these advantages, banana cultivation in Indonesia faces significant challenges from various pests that hinder plant growth and productivity. Farmers often struggle to effectively manage this pest, necessitating the development of an expert system to assist farmers and communities in accurately diagnosing pest problems and implementing appropriate control measures. This control is essential for improving pest management, increasing banana production, and supporting livelihoods that depend on this important crop. The continuous increase in Black Sigatoka intensity indicates that the pathogen *Mycosphaerella fijiensis* actively developed within banana leaf tissues during the observation period. The rise in disease severity from 31% at the first observation to 64% at the last observation suggests that the environmental conditions and plant growth stage were likely favorable for pathogen development. Plant disease progression is determined by the interaction among host, pathogen, and environment (disease triangle), and disease severity increases when these three components are optimal for pathogen growth. (Budiyanto *et al*., 2018).

In the case of Black Sigatoka, high humidity and moist environments accelerate fungal spore germination and conidia dispersion on leaf surfaces, and Smith and Johnson (2019) reported that *M. fijiensis* spreads more aggressively under wet conditions and on banana plants with dense canopies that retain leaf moisture for longer periods; additionally, increasing necrotic tissue over time provides a greater source of spores, thereby increasing infection intensity in subsequent observations, which demonstrates that without control measures, Black Sigatoka can severely reduce photosynthetic activity due to leaf tissue damage, ultimately decreasing banana yield, thus highlighting the urgency of implementing appropriate management practices such as pruning infected leaves, using resistant cultivars, applying eco-friendly fungicides, and integrating biological control strategies to suppress disease progression in banana plantations (Esguera *et al*., 2024).

Based on the background described above, the following problem formulations can be identified. what is the impact caused by *Black Sigatoka* disease on banana plants. This study is limited to discussing biotic stress factors that affect banana plants, specifically diseases Black Sigatoka. It does not include other abiotic stress factors such as drought, nutrient deficiency, or soil conditions. The discussion focuses on the impacts of these pests and diseases on the growth, yield, and quality of banana plants, without providing an in-depth analysis of control or management strategies. Furthermore, the analysis is based solely on information obtained from literature studies and does not involve direct field experimentation. The objectives of this study are as follows. First, to analyze the impact of *Black Sigatoka* disease on leaf condition and the overall productivity of banana plants.

Materials And Method

The study population consisted of 30 banana plants located at the study site. Given the small population size, all 30 plants were included as a sample to ensure comprehensive data collection. Sampling was conducted using the simple random sampling method. This method involves assigning a unique number to each plant, then writing the numbers on small pieces of paper, folding them, and placing them in a container. These pieces of paper were thoroughly mixed, and numbers were randomly drawn to determine the order in which the plants were observed. This randomization technique ensured that each plant had an equal opportunity to be assessed, minimized observer bias, and adhered to modern research standards for fairness and accuracy.

This study focused on biotic stress factors, specifically Black Sigatoka. Field observations were conducted through direct inspection of each plant to record visible symptoms of pest and disease attacks, including leaf damage, leaf holes, yellowing, or wilting. Absolute damage is permanent damage to the

ISSN No. 2988-1803
Vol 5. No. 1 :1-6, Mei 2026
https://ejournal.unmas.ac.id/index.php/agrofarm
Doi:

plant to be harvested, such as the death of all plant tissue and wilting. Furthermore, damage considered absolute includes rotting or partial destruction of plant tissue, rendering the plant or part of the plant unproductive (Lahati and Saifuddin, 2022). To calculate absolute damage, use the following formula:

$$I = \frac{n}{N} \times 100\%$$

Description:
I = Incidence of attack (%)
n = Number of affected offspring
N = Number of offspring observed

$$IP = \frac{\sum(n \times v}{Z \times N} \times 100\%$$

Description:
I = Intensit of attack (%)
n = Number of affected offspring
Z = Highest scoring total
N = Number of offspring observed

Pest attack intensity was measured using a scoring system adapted from Nurfadhilah et al. (2024):

• Score 0 = No infection
• Score 1 = Very light infection (1–20% of plant organs affected)
• Score 2 = Light infection (21–40%)
• Score 3 = Moderate infection (41–60%)
• Score 4 = Severe infection (61–80%)
• Score 5 = Very heavy infection (81–100%)

This scoring system replaces the use a straightforward quantitative assessment of damage intensity across samples. Observations were conducted for one month, in October 2025, from the early vegetative stage to fruit ripening. Plants were monitored every 7 days, resulting in four observation periods to consistently capture changes in pest populations and disease symptoms. This methodology ensures a systematic, unbiased, and measurable approach to studying pest and disease dynamics in banana plants, consistent with contemporary research. The variables observed in this study include several key aspects. First, the types of pests and diseases that affect banana plants. Second, the frequency of attacks occurring during the observation period. Third, the specific plant parts that are affected by these pests and disease.

Results And Discussion

Table 1.1 Results of Black Sigatoga Disease Intensity on Banana Plants (*Musa paradisiaca*)

Disease Intensity	Results Scoring
Observation 1	31%
Observation 2	37%
Observation 3	52%
Observation 4	64%

Description : Black Sigatoga intensity on banana plants increased consistently over time, beginning at 31% in Observation 1 and reaching 64% in Observation 4. This trend reflects the progressive spread of *Pseudocercospora fijiensis* under favorable conditions.

The results showed that the intensity of Black Sigatoka disease on banana plants increased progressively at each observation period. At the first observation, the disease intensity was recorded at 31%, then increased to 37% at the second observation. A more noticeable increase was observed at the third observation, reaching 52%, and the highest intensity was recorded at the fourth observation with 64%. Overall, these findings indicate that the severity of Black Sigatoka continued to increase over time, demonstrating the active development of the pathogen on banana leaves.

The results demonstrated a progressive increase in Black Sigatoka severity in banana plants across the four observation periods, with disease intensity rising from 31% in Observation 1, to 37% in Observation 2, 52% in Observation 3, and reaching 64% in Observation 4. This increasing trend indicates continuous development of the pathogen *Pseudocercospora fijiensis* within banana leaf tissues over time. During the early stages (Observation 1 and 2), disease intensity remained comparatively low

ISSN No. 2988-1803
https://ejournal.unmas.ac.id/index.php/agrofarm
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because infection was still in the initial lesion development phase and sporulation had not yet reached its peak. This corresponds to the pathogen's infection biology, which involves stomatal penetration followed by a latent period before visible streak-like lesions appear (Bebber, 2019).

The sharp increase in disease intensity at Observation 3 (52%) suggests a transition into an active necrotic phase, where lesions darken, leaf tissue begins to die, and sporulation becomes more abundant. The expansion of necrosis provides more inoculum sources, accelerating the spread of infection across the leaf surface. This escalation is consistent with the known pathogenic mechanism of *P. fijiensis*, in which fungal toxins induce cell death once exposed to light, resulting in the expansion of necrotic areas. The maximum intensity recorded in Observation 4 (64%) reflects advanced disease development, where widespread necrosis severely disrupts the photosynthetic capacity of the leaves and promotes a faster infection cycle due to increased spore availability (Kimunye *et al*., 2021).

The consistent increase in severity across observations reinforces the aggressive nature of Black Sigatoka, a disease capable of reducing banana yields by up to 80% if left unmanaged. Furthermore, the progressive disease development observed in this study suggests that environmental conditions were likely favorable for pathogen growth. High humidity, rainfall, and moist canopy conditions are known to enhance spore germination and dispersal of *P. fijiensis*. Therefore, the increasing intensity from Observation 1 to 4 not only reflects biological disease progression but also indicates that abiotic conditions supported pathogen establishment and infection. (Strobl and Mohan, 2020).

These findings highlight the importance of early and integrated disease management strategies, including removal of infected leaves, use of resistant cultivars, canopy management to reduce leaf wetness, and application of eco-friendly fungicides or biological control agents. Control measures should be implemented at early infection stages (similar to Observations 1 and 2) to prevent the rapid escalation observed in later phases (Observations 3 and 4), which pose greater risks of severe damage and yield loss (Agounet *et al*., 2024).

Table 1.2 Results of Black Sigatoga Disease Incidence on Banana Plants (*Musa paradisiaca*)

Disease Incidence	Results Scoring
Observation 1	80%
Observation 2	80%
Observation 3	86%
Observation 4	93%

Description : Black Sigatoga Incidence on banana plants increased consistently over time, beginning at 80% in Observation 1 and reaching 93% in Observation 4. This trend reflects the progressive spread of Pseudocercospora fijiensis under favorable conditions

Black Sigatoga disease incidence on banana plants showed a consistently high level of infection throughout the observation period. In Observations 1 and 2, disease incidence was already at 80%, indicating that most plants had been infected early. By Observation 3, incidence increased to 86%, and it reached 93% in Observation 4. This pattern illustrates the rapid spread and high infection pressure of Pseudocercospora fijiensis, especially under conditions that favor disease development.

The research results indicate that the incidence of Black Sigatoka disease in banana plants was high from the beginning of the observation period and continued to increase until the end of the observation period. In Observation 1, the disease incidence was recorded at 80%, and the same value was still found in Observation 2. An increase began to appear in Observation 3, with the incidence reaching 86%, and reached its highest value in Observation 4 at 93%. This pattern illustrates the active spread of the pathogen Pseudocercospora fijiensis in the study area.

The consistently high disease incidence in the first two observations (80% in Observations 1 and 2) indicates that the majority of plants were infected from the outset. At this stage, the infection is likely still in the early symptom development phase, when the spots haven't fully developed but the pathogen has successfully colonized most of the plant. This condition is consistent with the nature of P. fijiensis, which can survive on the leaf surface and infect thru the stomata before symptoms are clearly visible. The increase in incidence from 80% to 86% at Observation 3 indicates the onset of the pathogen's active dissemination phase. At this stage, the old spots begin to produce large quantities of conidia, which are then dispersed to healthy plants by wind, rain splash, or contact between leaves. The pathogen causing Sigatoka has a high sporulation capacity and spreads efficiently, especially in wet leaf conditions and high humidity. Therefore, the increase in infected plants observed in the third observation reflects an increase in the inoculum source and an acceleration of the infection cycle (Aguenot *et al*., 2024).

The highest incidence observed in Observation 4 (93%) indicates that the disease has progressed to an epidemic stage, where almost all plants in the observation area have been infected. At this phase, pathogen sporulation peaks, and the potential for secondary infection increases significantly. This aligns with Cobrado and Fernandez (2025) report stating that Black Sigatoka can spread very quickly in humid canopy conditions, causing almost the entire crop to become infected in a short time if not controlled. This condition has the potential to cause significant production losses due to a decrease in photosynthetic leaf area.

The increasing incidence in each observation also indicates that environmental conditions support disease development. Abiotic factors such as high humidity, rainfall frequency, and low air ventilation are ideal conditions for the germination of P. fijiensis spores. Bebber *et al*. (2019) emphasize that diseases caused by tropical fungi such as Sigatoka are highly dependent on the humid canopy microclimate, as wet leaves are a primary condition for infection. Thus, field conditions during the study likely accelerated the spread and development of the disease.

Overall, the high incidence values from the beginning to the end of the observation period confirm the aggressive nature of Black Sigatoka, which can cause yield losses of up to 50–80% if not controlled. Therefore, implementing integrated pest management strategies becomes crucial, including pruning infected leaves, improving canopy aeration, using tolerant varieties, applying orchard sanitation, and using environmentally friendly fungicides or biological agents. According to Aguonet *et al*. (2024), early control should be implemented in the initial phase of the epidemic before rapid spread, as seen in the later stages (Observations 3 and 4), because delayed management often results in extensive leaf damage and reduced crop productivity.

Conclusion

The study demonstrates that Black Sigatoga disease poses a serious threat to banana plants in Karang Bendo, with both disease intensity and incidence increasing throughout the four observation periods. Disease intensity rose from 31% to 64%, while incidence increased from 80% to 93%, indicating the rapid and aggressive spread of the pathogen under favorable environmental conditions such as high humidity and a moist canopy. This progressive development leads to leaf tissue damage, reduced photosynthetic capacity, and potential yield losses of up to 50–80% if left unmanaged. These findings highlight the urgent need for integrated disease management strategies, including field sanitation, pruning of infected leaves, use of resistant cultivars, improved canopy aeration, and application of eco-friendly fungicides or biological control agents. Such measures must be implemented early in the infection process to prevent the disease from escalating and to maintain sustainable banana production.

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