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The Incidence of Banana Bacterial Wilt in East Kutai Regency, East Kalimantan, Indonesia

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ABSTRACT

Bananas represent a significant horticultural commodity in Indonesia, with East Kalimantan Province emerging as a vital producer, particularly in East Kutai Regency, where intensive cultivation of kepok bananas is prevalent. Despite the region's projected 2024 banana production of 88,358 tons, productivity remains subpar, averaging less than 10 tons per ha, well below the potential of 35-40 tons per ha. This study investigates the incidence of bacterial wilt, a significant challenge for banana cultivation in tropical regions, across three sub-districts in East Kutai: Bengalon, Kaliorang, and Kaubun. Using direct observation and in situ sampling methods, the research identified disease symptoms and documented bacterial wilt among smallholder farmers. Field surveys revealed disease incidence rates exceeding 50% in Keraitan and Sempayau villages, reflecting severe outbreaks, while the other villages reported lower yet concerning rates. The findings suggest a critical need for improved agricultural practices, including advanced management techniques and the use of resistant seed varieties, to enhance banana production and resilience against this disease, ultimately contributing to sustainable agricultural output in the region.

Keywords: *Bananas, Bacterial Wilt, East Kalimantan, Agriculture Practices, Disease Incidence*

1. Introduction

Bananas rank among the leading horticultural commodities in Indonesia and hold significant promise for the future, bolstered by ample land availability and the economic value they provide to farmers and production areas. The East Kalimantan Province is ramping up its banana production to meet both domestic and export demands. Within this province, East Kutai Regency is the largest centre of banana production, particularly for the intensive cultivation of kepok bananas. In 2024, banana production in East Kutai reached 88,358 tons, accounting for approximately 55% of total banana output in East Kalimantan (BPS, 2025).

Despite the extensive development of banana cultivation, productivity in East Kalimantan remains notably low, with yields below 10 tons per ha, compared to the potential of 35-40 tons per ha (Rizal & Triwidyawati, 2015). Several factors contribute to the decline in banana production, with bacterial wilt identified as a significant barrier to banana cultivation in tropical regions (Aeny et al., 2007; Marín-Ortiz et al., 2024). The estimated yield loss from bacterial wilt within farmer groups ranges from 30% to 52% (Karamura et al., 2010). This disease continues to pose a challenge, as it remains difficult to control.

In East Kutai, the alarming rise in bacterial wilt has coincided with efforts launched by the East Kalimantan Provincial Food, Food Crops, and Horticulture Office to establish a comprehensive banana production centre in 2022. This initiative aims to enhance local agricultural output; however, the kepok banana variety has been identified as particularly susceptible to the debilitating effects of this disease (Ray et al., 2021).

To address this critical issue, a multifaceted approach is being implemented. This includes adopting advanced agricultural practices to improve cultural management, applying beneficial biological agents to suppress the disease, and using targeted bactericides to mitigate its spread. Additionally, the introduction of superior banana seed varieties is being pursued to strengthen resilience against bacterial wilt, ensuring a more robust and sustainable banana production for the region.

This study aims to assess the incidence of bacterial wilt in banana crops, explain its symptomatic manifestations, and critically evaluate the cultivation methodologies used in East Kutai.

2. Methodology

2.1. Study location

This study involved collecting samples from smallholder farmers who specifically cultivate bananas in East Kutai Regency (Figure 1), particularly in three subdistricts: Bengalon, Kaliorang, and Kaubun. The respective observation plots encompassed areas of 58, 40, and 55 ha. The landforms of these regions exhibit considerable variation, ranging from undulating lowlands along the coast to hilly terrain in the inland. The predominant soil types identified in these areas include red and yellow podzolic soils, latosol, and lithosol. These soil types are characterised by low fertility potential, which can be attributed to several factors, including steep gradient terrains and limited water availability.

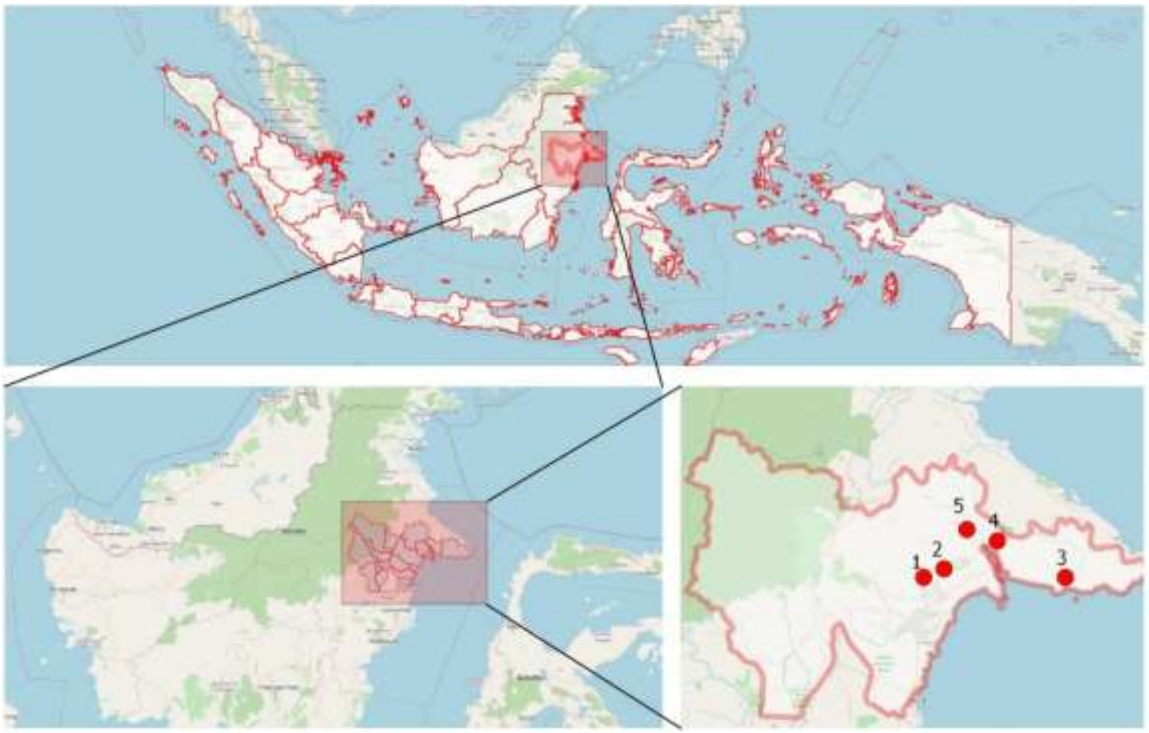

Figure 1. The designated sampling plots that exemplify banana production centres within East Kutai are as follows: 1) Keraitan, 2) Sekurau Atas, 3) Selangkau, 4) Sempayau, and 5) Kadungan Jaya.

2.2. Field survey

This study used a methodological framework that integrated survey techniques, specifically direct in situ observation and identification of banana bacterial wilt disease. At each designated sampling plot, 400 banana plants were systematically selected to facilitate targeted observation of those exhibiting symptoms of bacterial wilt. Field detection relied on the recognition of characteristic symptoms associated with the disease, which include: yellowing and wilting of leaves, cracked petioles accompanied by drooping foliage, exudation of bacterial ooze that varies in colour from yellow to reddish-brown at the transverse cut end of the pseudo-stem, and internal fruit decay, which may manifest while the exterior appears asymptomatic. All symptomatic instances of banana bacterial wilt encountered during the research were meticulously documented and captured using a digital imaging device. Additionally, information on banana cultivation techniques was obtained through interviews with local farmers to serve as corroborative data.

Given the wide distribution of banana plants, disease incidence is calculated visually in each banana population expanse using the model below.

$$DI = (n \div N) \times 100\%$$

Where,
DI = Disease incidence (%)
n = number of infected plants
N = number of plants observed

3. Results and Discussion

3.1. Disease incidence

The present study evaluated five villages designated as sample plots for banana cultivation: Keraitan and Sekurau Atas in Bengalon District, Selangkau in Kaliorang District, and Sempayau and Kadungan Jaya in Kaubun District. Rigorous field surveys revealed that none of the selected villages lacked infections attributable to bacterial wilt. Notably, Keraitan and Sempayau villages exhibited alarming disease incidence rates exceeding 50%, indicating severe outbreaks (Table 1). In contrast, the incidence of banana bacterial wilt in Sekurau Atas and Kadungan Jaya villages was measured at 21.25% and 22.75%, respectively. Selangkau village recorded the lowest incidence rate, at 16.75%.

Table 1. Incidence of banana bacterial wilt disease in East Kutai Regency

Districts	Villages	Farmland area (ha)	Disease incidence (%)
Bengalon	Keraitan	16	50.00
	Sekurau Atas	42	21.25
Kaliorang	Selangkau	40	16.75
Kaubun	Sempayau	35	53.25
	Kadungan Jaya	20	22.75

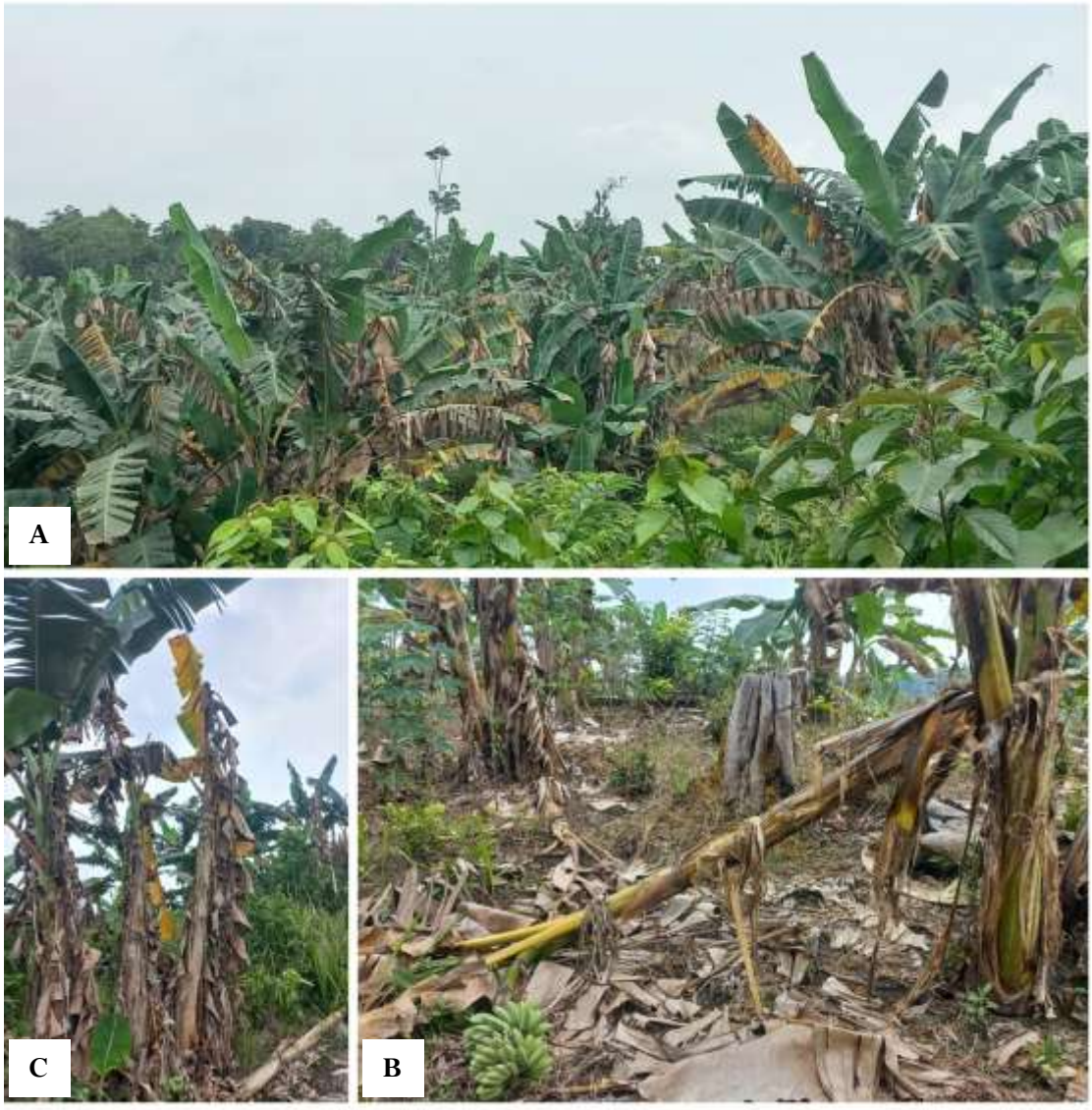

Figure 2. Cultivation conditions on sampling sites, which impact plant health and productivity: excessively dense planting (A), unharvested plants infected by pathogens (B), and uncleared, decomposing debris (C).

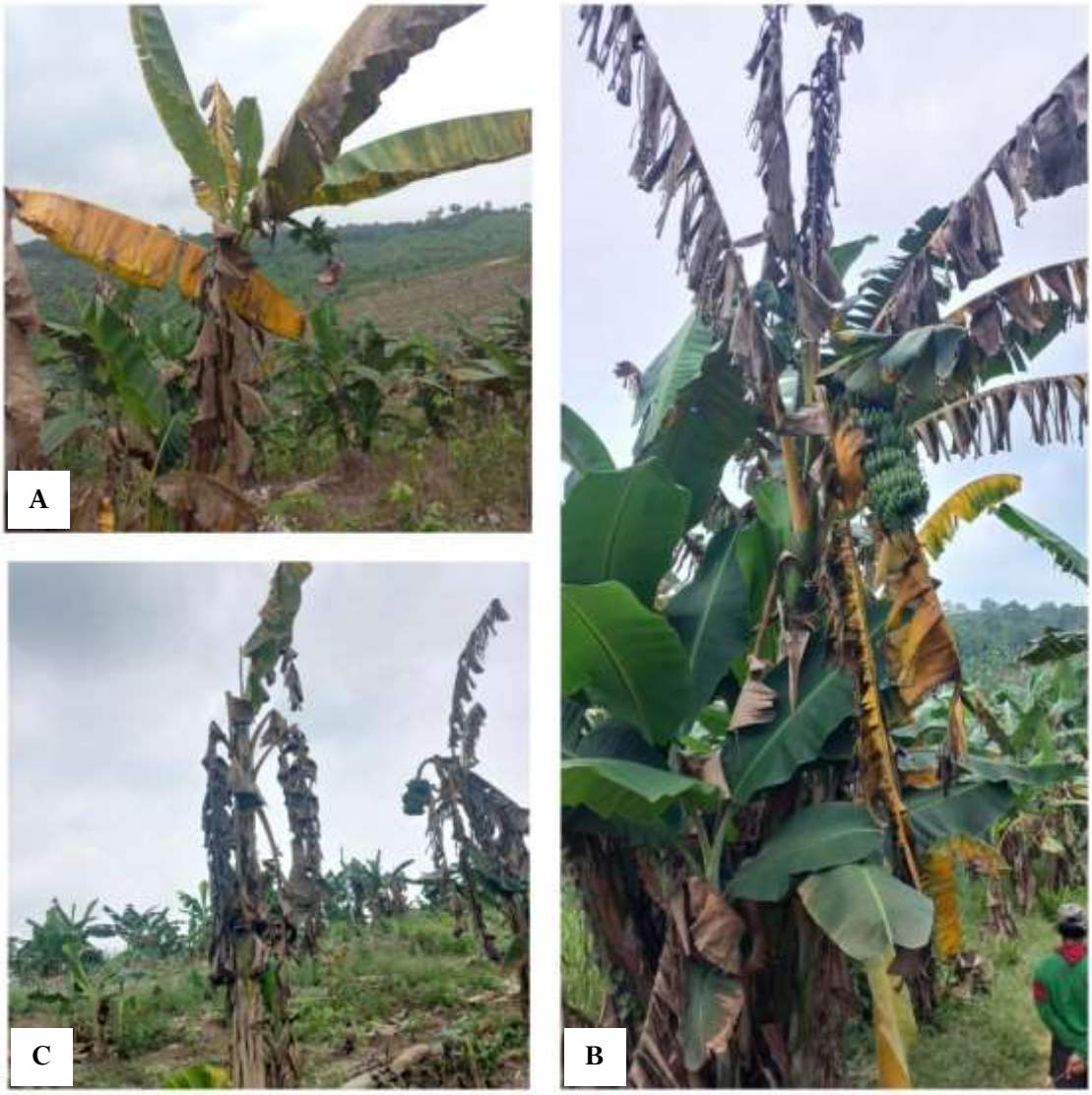

Figure 3. Banana bacterial wilt symptoms: yellowing and wilting that typically starts in the inner leaves (A); a distinct angular break on petioles, causing the leaves to hang or collapse (B); the plant's complete wilting and death (C).

Visual assessments and structured interviews with farmers regarding their agricultural practices revealed considerable neglect, characterised by unharvested plants and decomposing foliage (Figure 2). This condition was particularly pronounced in the villages of Keraitan and Sempayau. Such observations align with the elevated incidence of banana bacterial wilt recorded in both study locations, suggesting a correlation between the observed neglect and the prevalence of this plant disease. The escalation of bacterial wilt disease within the identified sample plots is postulated to stem from inadequate agricultural practices, such as insufficient cleaning and pruning. This lack of management likely contributed to heightened humidity retention around the banana plants, fostering an environment conducive to the infection and proliferation of the bacterial wilt pathogen (Ochola et al., 2015). Consequently, such conditions have led to increased damage to the banana plants and a detrimental impact on the overall productivity and quality of the banana yield.

The study into banana cultivation practices revealed that villages such as Selangkau, Sekurau Atas, and Kadungan Jaya implemented improved methods, resulting in banana bacterial wilt incidence below 25%. Key factors contributing to this success included the careful selection of healthy seedlings, the preparation of appropriate land conditions, adherence to optimal planting distances specific to the banana variety, rigorous maintenance of garden sanitation, and the implementation of essential maintenance practices, such as removing excess suckers. These practices collectively highlight the importance of effective agricultural management in mitigating disease prevalence in banana cultivation.

Figure 4. Effect of banana bacterial wilt on fruit premature ripening and fruit rot (A); a yellow-orange streaking and a creamy bacterial ooze (B); yellowing leaves and decaying male flower buds (C).

Based on empirical observations in the field, it has been noted that within a cluster of banana plants, some specimens exhibit resistance to bacterial wilt, while others succumb to the disease. These healthy plants possess an inherent resistance to the bacterial wilt pathogen, despite its classification as a soilborne bacterium capable of long-term persistence and propagation in the soil. Such phenomena warrant further investigation into the mechanisms underlying the resistance exhibited by these resilient banana plants.

3.2. Disease Symptoms

Observations of banana plants in Bengalon, Kaliorang, and Kaubun have identified bacterial wilt. The symptoms of this disease include progressive yellowing and wilting of leaves (Figure 3), along with rapid, premature fruit ripening that exhibits internal browning, leaf necrosis, and decay of male flowers and bunches (Figure 4). Ultimately, the plant withers and rots. A cross-section of the pseudo-stem reveals brownish discolouration, and over time, a brownish-yellow or reddish-brown bacterial ooze forms on the cut surface (Figure 5). These symptoms align with the descriptions of bacterial wilt in bananas documented by Mustafa et al. (2022) and Mogea et al. (2025).

Damage inflicted by bacterial wilt, a disease caused by pathogens that infect banana plants, disrupts the vascular system, leading to wilting (Addy et al., 2016). According to Blomme et al. (2017), three groups of pathogens cause banana bacterial wilt, namely i) Ralstonia (which includes Moko/Bugtok disease caused by *Ralstonia solanacearum* and blood disease caused by *R. syzygii*); ii) Xanthomonas (which leads to withering disease caused by *Xanthomonas campestris*); and iii) Erwinia (responsible for bacterial rot caused by *Erwinia carotovora* and *E. chrysanthemi*).

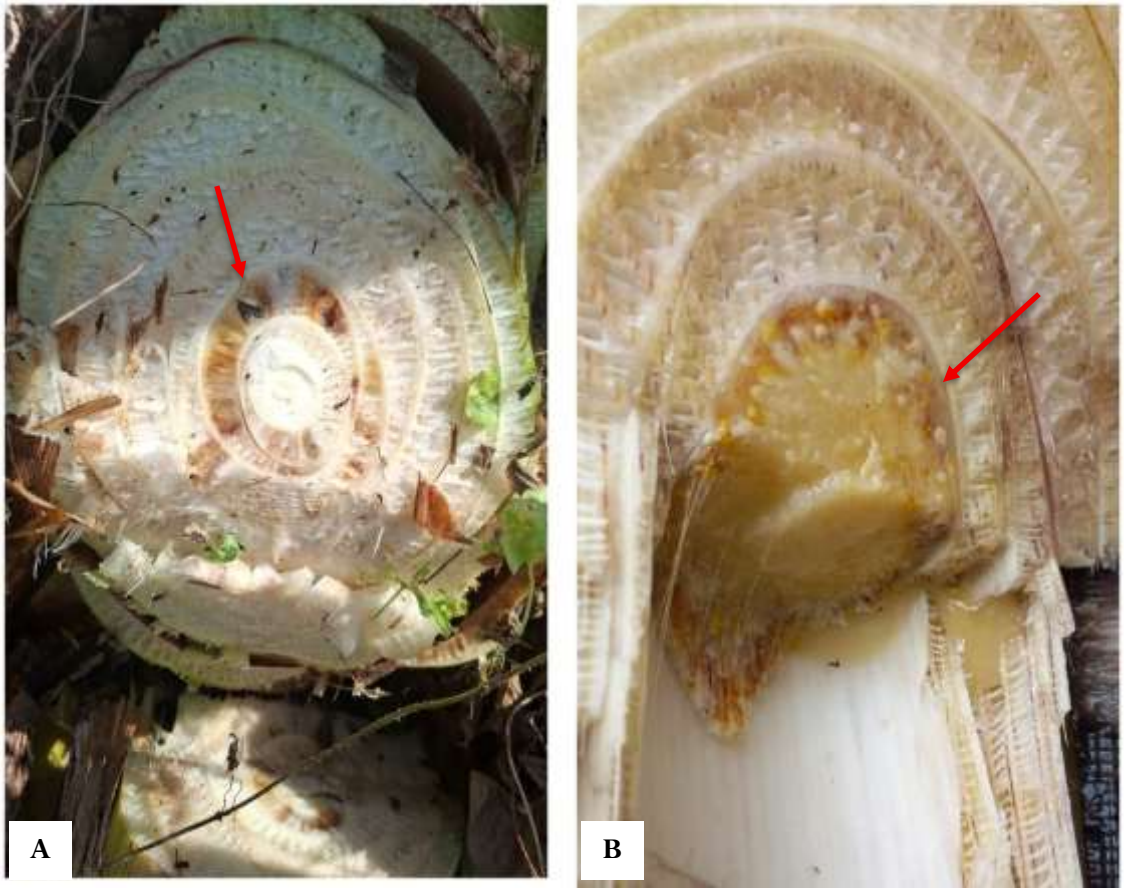

Figure 5. The symptoms of bacterial wilt in the banana plant: a discoloured vascular system within the pseudo-stem, ranging from yellowish to brownish (A); emerge of a distinct yellow ooze upon incision of the pseudo-stem (B).

Bacterial wilt symptoms in banana plants are visually evident and distinguishable from those caused by the pathogenic fungus *Fusarium oxysporum*, which leads to Panama disease (Table 2). According to Effendi et al. (2018), symptom emergence in banana plants infected with bacterial wilt occurs more slowly compared to that associated with *F. oxysporum*. This slower manifestation may be attributed to diminished bacterial motility within the plant (Tans-Kersten et al., 2001). However, laboratory tests are essential for accurately diagnosing the cause of banana plant diseases in East Kutai, as visual symptoms alone are insufficient for accurate identification.

Table 2. Differentiation of symptoms by bacterial wilt and Fusarium wilt (Pérez-Vicente et al., 2014)

Bacterial wilt	Fusarium wilt
Symptoms usually progress from younger to older leaves	Disease symptoms progress from older to younger leaves
Young emerging buds can be distorted and necrotic, eventually dying	No symptoms in young growing buds or suckers
Bacterial ooze can be observed on exposed cut surfaces (roots, pseudostem, rachis, flowers, rhizome, etc.)	No exudations in exposed surfaces
Internal fruit rot and necrosis develop	No development of symptoms in fruits

3.3. Management

The initial objective of this study was to identify banana production centres in East Kutai free of bacterial wilt pathogens. The plan was to use these pathogen-free locations as sources for developing banana seedlings for East Kalimantan. Among the surveyed areas, the village of Selangkau, located in the Kaliorang Subdistrict, indicates significantly greater potential as a seed source for establishing banana production centres. The survey results show that the incidence of bacterial wilt in Selangkau is notably lower, likely due to the implementation of effective farming practices.

The initiatives aimed at enhancing banana production in some areas of East Kalimantan are significantly hampered by the prevalence of bacterial wilt, a disease characterised by rapid transmission. Addressing this phytopathological challenge necessitates targeted interventions, particularly the provision of high-quality, disease-free planting materials. The successful propagation of such seeds requires careful consideration of several factors, including the genetic origin of the seeds, the selected propagation methods, and comprehensive maintenance protocols throughout the growth cycle until the seeds are distributed for cultivation.

Managing bacterial wilt disease in East Kutai remains an ongoing challenge. Effective management strategies include a combination of preventive measures to curb the spread of the disease, curative actions to destroy infected plants, and the rehabilitation of previously affected areas (Geberewold, 2019). Information campaigns, technical assistance, and financial support from the national government are vital for these efforts.

4. Conclusions & Recommendations

In conclusion, the study highlights the significant impact of bacterial wilt on banana production in East Kutai, East Kalimantan. The alarming incidence rates observed, particularly in Keraitan and Sempayau villages, underscore the severity of the outbreaks and the urgent need for effective management strategies.

The low level of awareness and poor agricultural practices observed among farmers further exacerbate the situation, underscoring the need for targeted interventions. The implementation of advanced agricultural practices, the introduction of disease-resistant banana varieties, and the application of beneficial biological agents are essential strategies to mitigate the impact of bacterial wilt and improve production resilience.

Moving forward, a concerted effort involving local farmers, agricultural experts, and government agencies is crucial to combat this disease effectively and support the sustainable growth of the banana industry in East Kutai. Enhanced training and education on best cultivation practices, along with ongoing monitoring and research, will be vital to overcome the hurdles posed by bacterial wilt and secure a more prosperous future for banana production in the region.

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