# Pest and Disease Challenges in Oil Palm (*Elaeis guineensis* Jacq) Seedling in Sukamara, Central Borneo, Indonesia

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*Article history:*
Submitted : 22 December 2024
Received : 22 January 2025
Accepted : 14 February 2025
Published : 28 February 2025

**To cite this article:**
Simanjuntak, W.F., Kusuma, R.M., Wiyatiningsih, S., Zulperi, D. 2025. Pest and Disease Challenges in Oil Palm (*Elaeis guineensis* Jacq) Seedling in Sukamara, Central Borneo, Indonesia. Agriverse 1(1): 12 – 22

**Abstract**

Oil palm (*Elaeis guineensis* Jacq) is one of Indonesia's leading agricultural commodities, with high-quality seedlings playing a critical role in optimizing crude palm oil (CPO) production. However, oil palm cultivation is highly susceptible to various pests and diseases, including *Curvularia* sp., which poses a significant threat to nursery production. This study identifies the potential oil palm's pests and diseases in nurseries of Sukamara Regency, Central Borneo. Field observations were conducted in the oil palm nursery and production area to assess pest infestations and disease occurrences. The frequency and intensity of *Curvularia* sp. infection were recorded and analyzed. Zig-zag sampling revealed key-pest - the rhinoceros beetle (*Oryctes rhinoceros*), armyworm (*Spodoptera* sp.), grasshoppers, and bagworms (*Metisa plana*)- and *Curvularia* sp. leaf spot disease, with an intensity of 2.09%, classified as low damage. The relatively low incidence of this disease is attributed to environmental conditions, cultural practices, and existing pest and disease management strategies. A comprehensive understanding of the pest and disease spectrum in oil palm plantations is essential for developing effective control strategies. Strengthening integrated pest and disease management practices is crucial to ensuring seedling quality and sustaining optimal CPO production.

***Keywords:*** *Curvularia, Metisa plana, Oryctes rhinoceros, Spodoptera* sp

## Introduction

Palm oil (*Elaeis guineensis* Jacq.) is one of Indonesia's most important agricultural commodities, contributing significantly to the national economy through exports and employment generation (Aisyah & Kuswantoro, 2017). This sector has a high economic value, with palm oil exports surpassing those of most other agricultural products, making it a crucial component of Indonesia's non-oil and gas export revenue (Noviantoro et al., 2017). In 2019, Indonesia's palm oil exports were valued at USD 19 billion, marking a 17.39% decline from USD 23 billion in 2018. This decrease was largely attributed to lower international palm oil prices, despite a 4.21% increase in export volume from 34.71 million tons in 2018 to 36.17 million tons in 2019 (Advent et al., 2021). The growing global demand for palm oil underscores the need for sustainable production practices, aligning with the Sustainable Development Goals (SDGs), particularly in addressing economic growth, food security, and environmental conservation.

Ensuring sustainable palm oil production requires a focus on high-quality seedlings, as superior planting materials significantly influence crop yield. However, oil palm nurseries in Indonesia face challenges from pests and diseases, including *Curvularia* sp., a fungal pathogen responsible for leaf spot disease, which can affect up to 38% of seedlings (Susanto et al., 2013). If left unmanaged, this disease can reduce plant vigor and hinder plantation productivity. Effective control measures must consider disease severity, environmental factors, and long-term sustainability to minimize losses and support continued production.

The expansion of oil palm plantations in regions such as Central Kalimantan demonstrates the industry's rapid growth. According to the Indonesian Central Statistics Agency (BPS), in 2018, oil palm plantations in Central Kalimantan covered approximately 1.5 million hectares, yielding over 5.16 million tons of Fresh Fruit Bunches (FFB). However, several obstacles threaten productivity, including aging plantations exceeding their optimal production age of 25-30 years and various pests such as leaf-eating caterpillars, bagworms, nettle caterpillars, rhinoceros beetles, and mammalian pests like rats and wild boars (Widians & Rizkyani, 2020). These challenges highlight the importance of integrated pest and disease management strategies to sustain plantation productivity.

PT Sungai Rangit, a subsidiary of Sampoerna Agro Tbk, is one of the major oil palm companies in Central Borneo, contributing significantly to Indonesia's palm oil output. The company operates extensive nurseries, yet its productivity is affected by pest and disease infestations. Identifying the key pests and diseases in PT Sungai Rangit's plantations is crucial for developing effective control measures that ensure sustainable production. By addressing these challenges, the palm oil industry can contribute to the achievement of SDG 2 (Zero Hunger) by enhancing agricultural productivity, SDG 8 (Decent Work and Economic Growth) by supporting employment in rural areas, SDG 12 (Responsible Consumption and Production) by promoting sustainable agricultural practices, and SDG 15 (Life on Land) by implementing environmentally friendly pest and disease management strategies.

By integrating sustainable cultivation methods, utilizing disease-resistant seedlings, and adopting eco-friendly pest control measures, the palm oil industry can enhance productivity while reducing environmental impacts. Strengthening sustainable agricultural practices will ensure long-term economic viability, food security, and ecological balance, in line with the broader objectives of global sustainable development.

**Materials and Methods**

This study was conducted in the oil palm plantation area of Telaga Bintang Estate and the oil palm nursery area of Waringin Estate, both owned by PT. Sungai Rangit, located in Telaga Bintang Estate, Sukamara District, Sukamara, Central Borneo (Figure 1). The oil palm trees in Telaga Bintang Estate were 23 years old, while the seedlings in the nursery were 8 months old (main nursery stage). Observations were carried out in August 2024 with an average temperature of 28 °C and rainfall of 50 mm. The materials used in this study included Marihat variety oil palm trees and Sriwijaya Semi Clone 1 variety oil palm seedlings aged 8 months, with a total of 560 seedlings. The equipment utilized for data collection consisted of a calculator, camera, tally sheet, and writing instruments. This research aimed to assess potential pest and disease infestations in oil palm plantations and nurseries, ensuring the selection of appropriate management strategies for sustainable cultivation.

The research methodology consisted of several stages. First, a literature review was conducted to gather information on symptoms caused by pests and *Curvularia* sp. and to obtain relevant supporting data. This step was essential in identifying potential threats to oil palm seedlings and understanding previous research findings related to pest and disease infestations. Field observations were then carried out to identify pest infestation symptoms, the total number of seedlings in the study area, and the overall condition of the plantation and nursery. This involved a direct assessment of affected seedlings and an evaluation of environmental factors that might contribute to pest and disease outbreaks. The sampling process followed a zigzag pattern, with four samples taken from each row of plants (Kundu et al., 2023). Sampling was conducted in every $10^{th}$ row within a single nursery plot. The nursery area consisted of 14 plots, each containing 100 rows, resulting in a total of 560 oil palm seedlings being sampled for further analysis. Pest infestation assessment was performed by visually identifying symptoms and signs on affected parts of the oil palm seedlings. Additionally, efforts were made to locate adult pest specimens (imago) in the study area for accurate species identification. Disease incidence assessment was conducted by observing symptoms and disease signs caused by *Curvularia* sp. and other pathogens in each sampled seedling. All findings were systematically documented in a tally sheet to facilitate data analysis and ensure accuracy in reporting infestation levels.

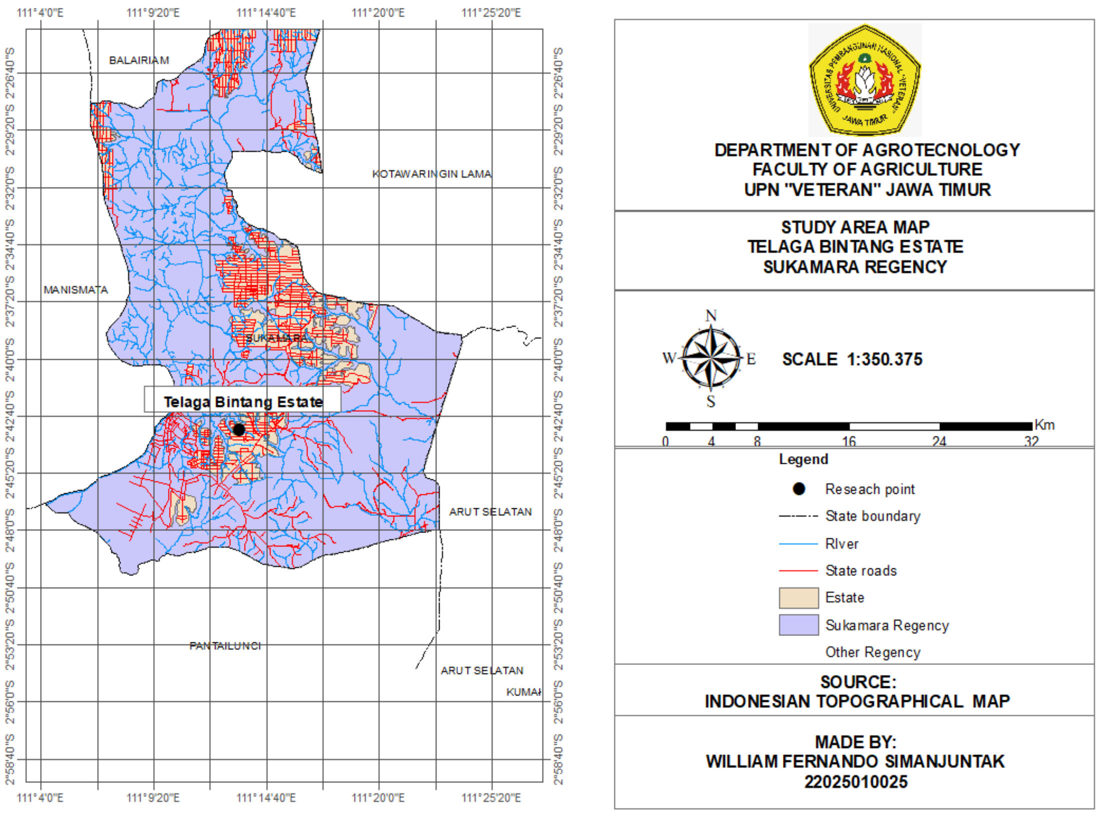


Figure 1. Research location based on web-maps geospatial platform.

Table 1. Mechanism for determining the score of disease symptoms on each seedling

| Plant Symptoms | Score |
|---|---|
| Healthy (no visible disease symptoms) | 0 |
| Mild infection (few affected leaves with minor symptoms on each leaf) | 1 |
| Moderate infection (several affected leaves with moderate symptoms on each leaf) | 2 |
| Severe infection (many affected leaves with extensive symptoms on each leaf) | 3 |
| Dead (all leaves wilted with no signs of life) | 4 |

**Disease Severity**

To determine the disease intensity (IS) was measured using a formula adapted from de Guzman (1985), Singh and Mishra (1992), and later modified by Mardji (1994).

$$IS = \frac{X1Y1 + X2Y2 + X3Y3 + X4Y4}{XY4} \times 100$$

In this formula: X represents the total number of observed plants, $X_1$ to $X_4$ indicate the number of plants experiencing varying degrees of infection, from mild to severe, including plant mortality, $Y_1$ to $Y_4$ correspond to scores ranging from 1 to 4, representing increasing severity levels. Once the disease intensity (IS) was determined, the level of plant damage was categorized to assess the severity of pathogen attacks in the observation area. The classification of plant conditions based on disease intensity is presented in Table 2, which provides criteria for determining the impact of pathogen infection on plant health (Defitri & Marcelian, 2023).

Tabel 2. Criteria for Determining Plant Condition Due to Pathogen Attack Based on Attack Intensity.

| Disease Severity (%) | Plant Condition |
|---|---|
| 0.0 – 1.0 | Healthy |
| 1.1 – 25.0 | Slightly Damaged |
| 25.1 – 50.0 | Moderately Damaged |
| 50.1 – 75.0 | Severely Damaged |
| 75.1 – 100 | Extremely Damaged |

## Result and Discussion

### Potential Pest

Insect pests, although naturally occurring in forest ecosystems, can become a significant concern when their populations increase uncontrollably, leading to defoliation, tree mortality, and ecological imbalances (Agustin et al., 2024). Such disturbances have far-reaching consequences, affecting forest health and the ecological services they provide (Rumondang et al., 2024). Several potential pests that threaten oil palm include the rhinoceros beetle (*Oryctes rhinoceros*), armyworm (*Spodoptera* sp.), bagworm (*Metisa plana*), and grasshopper (*Valanga nigricornis*).

### Rhinoceros Beetle (*Oryctes rhinoceros*)

The infestation of the rhinoceros beetle in the Telaga Bintang Estate plantation was classified as mild. Consequently, no specific pest control measures were implemented against this beetle species. The life cycle of *O. rhinoceros* consists of four stages: egg, larva, pupa, and adult (imago). The larval stage comprises three instars, during which the larvae develop within decaying organic matter, particularly empty fruit bunches. As illustrated in Figure 2A, the third instar larvae of *O. rhinoceros* were observed inhabiting the decomposing organic material beneath the oil palm plantation. Following the larval phase, the insect undergoes pupation before emerging as an adult beetle, as depicted in Figure 2B.

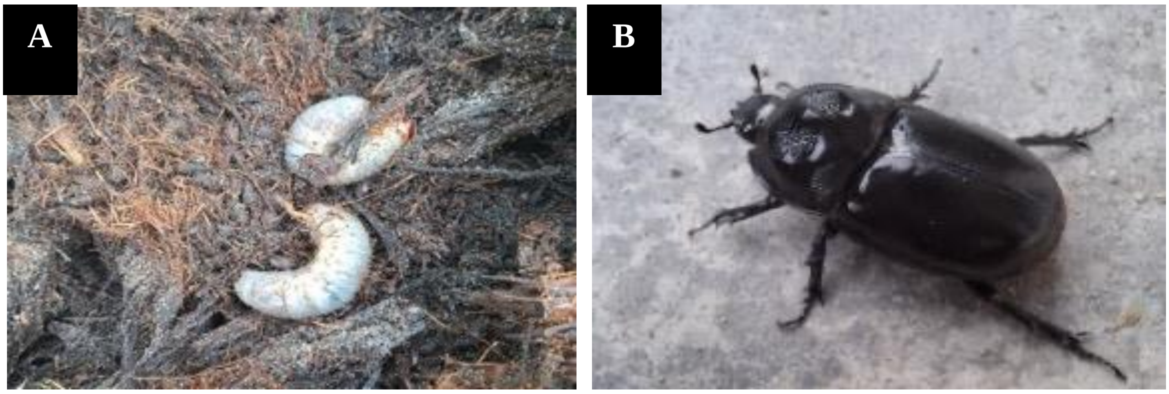


Figure 2. Pest Rhinoceros Beetle (*O. rhinoceros*) (A) Third Instar Larva (B) Adult (Imago)

Infestation by the *O. rhinoceros* in oil palm plantations can result in significant yield losses, reducing harvest output by up to 60% during the first production cycle and causing a mortality rate of approximately 25% in immature plants. The adult beetles are nocturnal and typically fly to the palm canopy at night. They target the uppermost fronds, burrowing into the base of unopened young leaves. As a result, feeding damage becomes evident when the leaves unfold, displaying characteristic triangular cuts, which are a distinct symptom of *O. rhinoceros* infestation. Severe attacks can lead to plant death, and both young and mature oil palms are susceptible to infestation by both male and female beetles (Susanti et al., 2020).

The symptoms of *O. rhinoceros* infestation can be classified based on the growth stage of the plant, namely the nursery stage and the mature production stage. In the nursery stage, *O. rhinoceros* primarily targets eight-month-old oil palm seedlings. Symptoms are observed at the base of the stem, where feeding activity results in extensive tunneling. This feeding disrupts vascular tissues, leading to wilting and eventual death of young leaves, as illustrated in Figure 3A. Another key indicator of rhinoceros beetle infestation in seedlings is the presence of entry holes near the stem base, which serve as access points for the larvae as they consume the internal tissues. In mature oil palm plants, infestation symptoms are visible in the spear leaves, as depicted in Figure 3B. Damage is characterized by broken fronds at the growing tip of the palm, as shown in Figure 3C. The damage is caused by beetle feeding activity, which weakens the plant structure and leads to significant reductions in growth and productivity. Effective monitoring and early detection of *O. rhinoceros* symptoms are crucial for preventing severe infestations and minimizing economic losses in oil palm plantations.

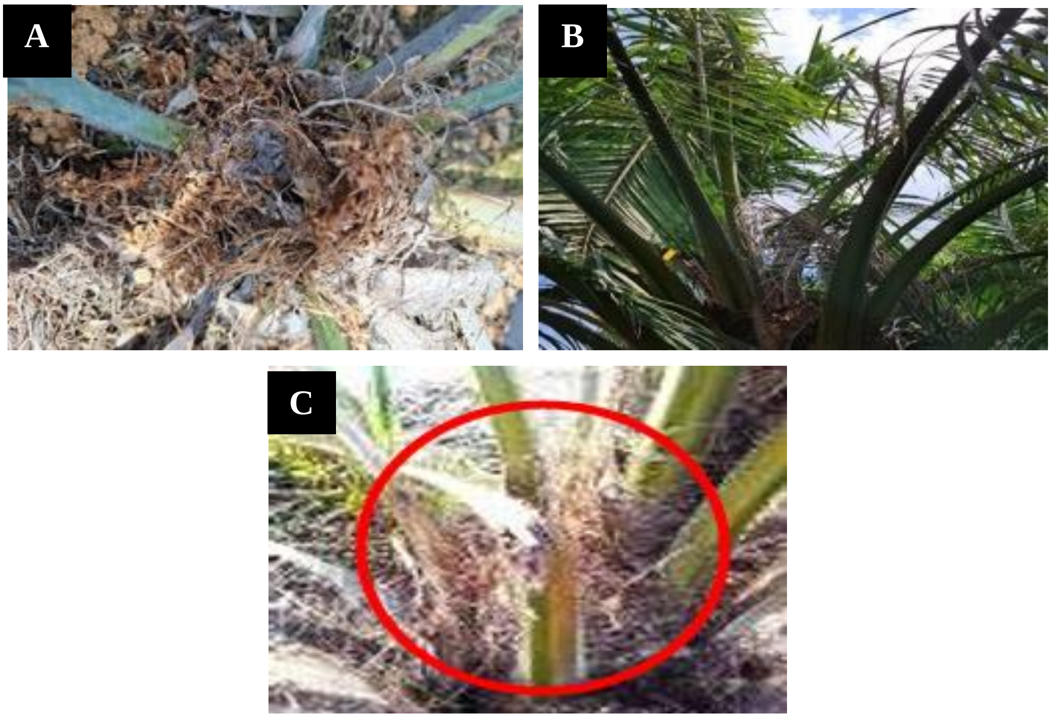


Figure 3. Symptoms of *O. rhinoceros* Infestation (A) Nursery Stage (B) Mature Oil Palm (C) Mature Oil Palm (Lukmana & Alamaudi, 2018)

**Armyworm (*Spodoptera* sp.)**

Seedlings of oil palm in the plantations of PT. Sungai Rangit were found to have numerous perforated leaves. One of the primary causes of this foliar damage is the armyworm, an invasive polyphagous pest with a broad host range. According to Montezano et al. (2018), *Spodoptera* sp. is capable of infesting 353 plant species across 76 families.

The eggs of *Spodoptera* sp. are laid nocturnally on the leaves of host plants, typically on the underside of lower leaves. Each egg mass contains approximately 100–300 eggs, sometimes arranged in two layers, and is covered with a protective layer of abdominal hairs. The incubation period ranges from 2 to 10 days, with an average of 3–5 days under normal conditions. The eggs are spherical (approximately 0.75 mm in diameter), initially green upon oviposition and gradually turning light brown before hatching. Under optimal temperatures (20–30 °C), hatching occurs within 2–3 days.

The larvae exhibit color variations from light green to dark brown, with distinct longitudinal stripes. At the sixth instar stage, larvae reach a length of approximately 3–4 cm. The larval body is equipped with eight prolegs and an additional pair on the terminal abdominal segment. Upon hatching, the larvae are green with black spots and stripes. As they mature, their color remains green or transitions to brownish, with a characteristic black dorsal stripe and spiraling lateral lines. Young larvae tend to aggregate in the apical whorls of the plant, feeding on the shoot tips and leaving characteristic frass deposits, as illustrated in Figure 4A. The first-instar larvae exhibit gregarious feeding behavior on the lower surface of young leaves, causing a distinct 'skeletonizing' or 'windowing' effect, which may lead to the death of the growing point, as shown in Figure 4B (Lubis et al., 2020).

A study by Mulyani et al. (2024) confirmed that the symptoms observed in Figure 4A were consistent with those documented in field studies, as illustrated in Figure 4D. The morphological characteristics of *Spodoptera* sp. larvae include a dark head capsule featuring an inverted Y-shaped marking, a distinctive network pattern on the ocular region, three yellow dorsal lines, and four pinacula arranged in a curved pattern on the second-to-last abdominal segment. Additionally, the larvae possess four pairs of prolegs, with the arrangement of pinacula forming a trapezoidal shape on several other segments, each bearing setae (Mulyani et al., 2024). These morphological traits align with the fall armyworm specimens collected in the field, as depicted in Figure 4C.

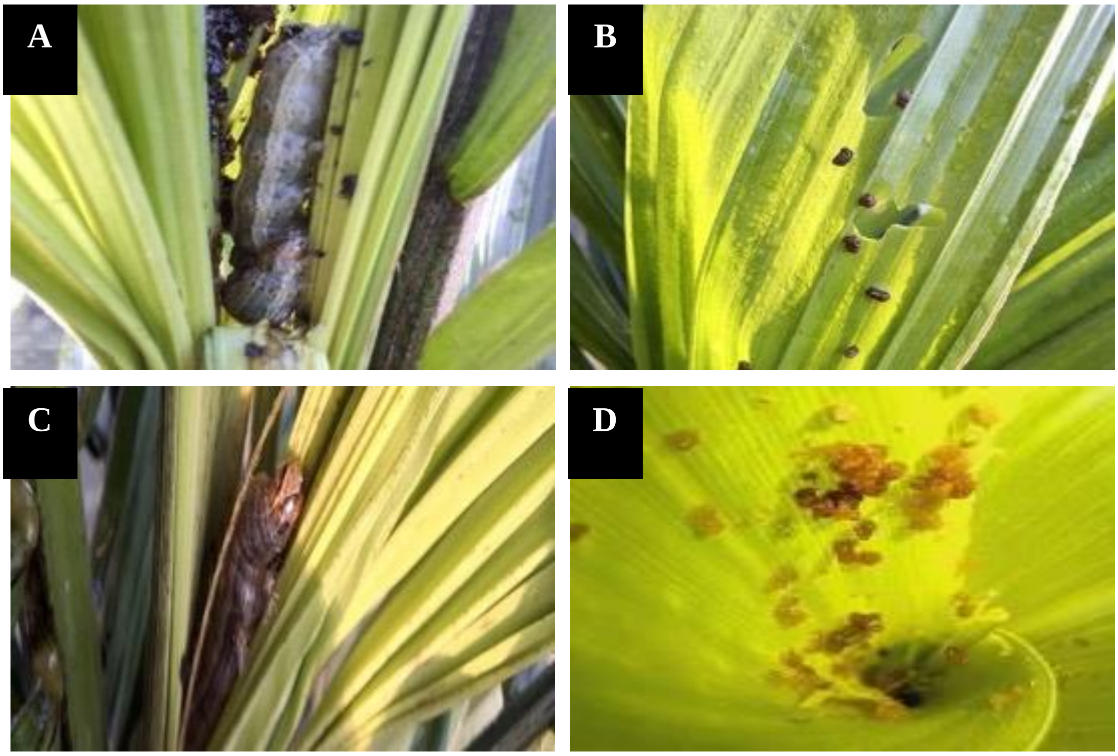


Figure 4. Armyworm (*Spodoptera* sp.) Infestation (A) Habitat (B) Symptoms of Infestation (C) Morphology of Spodoptera sp. Head Capsule (D) Symptoms of Infestation (Source: Mulyani et al., 2024)

**Green Grasshopper (*Atractomorpha* sp.)**

Grasshoppers are common pests in oil palm nurseries, where they primarily feed on seedling leaves, causing varying degrees of damage (Figure 5B). Grasshoppers belong to the order Orthoptera and are easily recognizable due to their distinct morphological features. Their bodies consist of three main segments: the head, thorax, and abdomen (Figure 5A). The head houses a pair of large compound eyes that detect movement and light, three simple eyes (ocelli) for light orientation, and long, slender antennae that function as sensory organs for detecting odors and environmental changes. The grasshopper's mandibles are well-developed, enabling it to cut and chew vegetation efficiently (Bambang et al., 2019).


Figure 5. Green Grasshopper (A) Imago (B) Symptoms on Oil Palm Leave

**Bagworm (*Mahasena corbetti*)**

Bagworm infestations pose a significant threat to oil palm plantations, with *M. corbetti* (Lepidoptera: Acrolophidae), *Metisa plana* (Lepidoptera: Acrolophidae), and *Crematopsyche pendula* (Lepidoptera: Acrolophidae) being among the most commonly reported species affecting these crops. These pests exhibit rapid dispersal capabilities, primarily due to their ability to move easily between leaves and trees, which facilitates widespread infestations within a short period.

Bagworms inflict damage on oil palm trees as they feed on the foliage to support their growth and construct protective silk cases. The feeding activity of these larvae results in severe defoliation, leading to incomplete, damaged, and perforated leaves. The initial phase of leaf damage typically begins with the epidermal layer, followed by progressive desiccation of young leaves that initially appear green but eventually dry out, as illustrated in Figure 6A.

This progressive damage impairs the plant's photosynthetic capacity, ultimately affecting its productivity and health. Larvae of bagworms exhibit a strong preference for consuming the upper leaves of the palm, which serve as their primary feeding sites. In contrast, the lower leaves often provide a suitable habitat for the larvae to suspend themselves and construct their characteristic protective cases, as depicted in Figure 6B. This behavior further exacerbates the infestation, as it facilitates their survival and reproduction, contributing to the overall population increase within the plantation (Riady et al., 2020).

The rapid spread and destructive feeding behavior of bagworms necessitate timely and effective pest management strategies. Integrated pest management (IPM) approaches, including biological control methods, cultural practices, and targeted insecticide applications, are essential to mitigate the impact of bagworm infestations on oil palm plantations. Continuous monitoring and early detection are crucial in preventing severe outbreaks that could lead to substantial yield losses and long-term damage to plantation productivity.

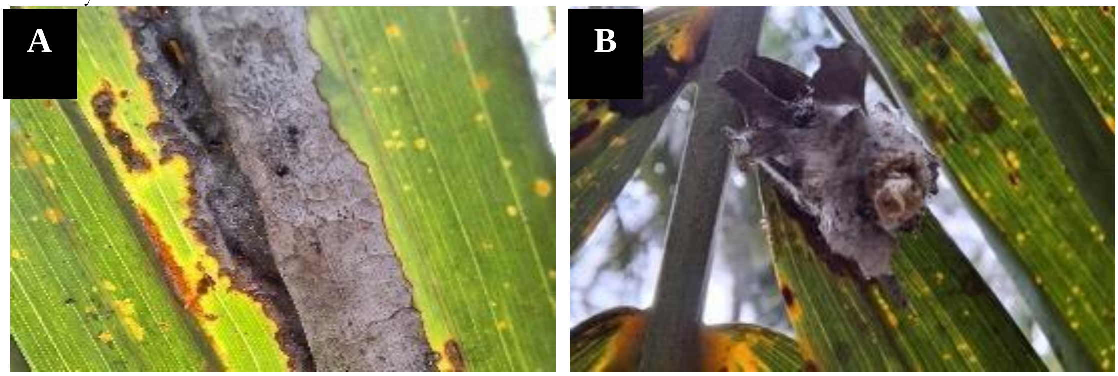


Figure 6. Bagworm (A) Symptoms on Oil Palm Leave (B) Larva Forming a Bag

The bagworm is a highly mobile pest capable of rapidly spreading from one leaf to another or from one tree to another. This mobility facilitates its ability to cause significant damage to oil palm plantations. The larvae feed on the leaves of oil palm trees to support their growth and construct protective bags. Infestation by bagworms leads to incomplete, damaged, and perforated leaves. Initially, the damage begins with the degradation of the leaf epidermis, eventually resulting in the desiccation of young green leaves. The larvae prefer to consume the upper leaves, while the lower leaves serve as sites for larvae to suspend themselves and construct their characteristic protective bags. The extent of damage to oil palm trees becomes more evident when defoliation reaches 50% (Pamuji et al., 2020).

In the Telaga Bintang Estate oil palm plantation, no control measures have yet been implemented against bagworm infestations. The current infestation level remains minimal, and therefore, intervention is not deemed necessary. Control measures are only recommended when the infestation surpasses the economic threshold. Effective management of bagworms can be achieved through the conservation of natural enemies within the oil palm ecosystem. The use of synthetic chemical insecticides is considered a last resort, and when necessary, the selection of insecticides and application techniques should prioritize environmental safety, particularly to preserve the survival of parasitoids and predators targeting the pest.

The conservation of natural enemies, such as predators, parasitoids, and entomopathogenic microorganisms, is crucial due to their significant role in regulating bagworm populations. Notably, the predators *Sycanus dichotomus* and *S. leucomesus* (Hemiptera: Reduviidae) as well as *Callimerus arcufer* (Coleoptera: Cleridae) are the primary predators of bagworms, particularly *M. plana*. These predators, when acting collectively, can reduce bagworm populations by up to 50% (Hanifah & Kusumah, 2020).

**Curvularia Leaf Spot (*Curvularia* sp.)**

Curvularia leaf spot affects oil palm seedlings, particularly the unopened leaf shoots or those that have partially unfolded. The initial symptoms manifest as small, circular, translucent yellow spots visible on both surfaces of the leaves. These spots gradually enlarge, maintaining a circular shape while turning light brown with a depressed center. Over time, the spots darken to a deep brown color and are surrounded by an orange-yellow halo (Lalang & Syahfari, 2016). Field observations confirmed the presence of Curvularia leaf spot in the plantation, with varying levels of disease intensity and frequency among affected seedlings. The rapid spread of the disease is attributed to the dissemination of fungal spores on oil palm seedling leaves (Cameron et al., 2024), supporting the observed variation in disease incidence within the affected nursery plots.

The severity of *Curvularia* sp. infection was quantified by calculating the Disease Intensity (DI). The assessment on eight-month-old seedlings revealed a disease intensity of 2.09%, categorizing the infection as mild (Slightly Damaged). This relatively low severity is attributed to routine fungicide application, which occurs twice weekly. The fungicides used contain the active ingredients benomyl and mancozeb. Benomyl exhibits an eradicative function by inhibiting mycelial growth before or after infection, while chlorothalonil, mancozeb, and propineb are broad-spectrum contact fungicides that inhibit multiple biochemical sites within pathogen organelles (Andriani et al., 2017). These findings indicate that both active ingredients effectively suppress the spread of *Curvularia* sp., which causes leaf spot in oil palm seedlings in the study area. Additionally, fungicide rotation and mixing strategies are crucial to preventing resistance, thereby improving the effectiveness of pathogen control (Irham et al., 2023). The rotation of benomyl and mancozeb serves as a preventive measure against the development of fungicide-resistant Curvularia strains. Given the continuous expansion of oil palm nurseries, coupled with potential fungicide resistance and climate change, disease incidence is expected to increase over time (Diyasti & Amalia, 2021).

Despite its efficacy, exclusive reliance on chemical fungicides can have detrimental effects on plant health and the surrounding environment. Alternative control measures have been proposed, including the use of photon energy irradiation, which has demonstrated effectiveness in suppressing plant disease development in field trials (Al Maududy et al., 2021). Moreover, research by Yusmar et al. (2023) identified 1.5% areca palm liquid smoke as the optimal concentration for inhibiting *Curvularia* sp. growth. The application of liquid smoke was also found to reduce the colony diameter of *Colletotrichum* sp. (Suyanto et al., 2021), with a 0.32% concentration yielding a 29.13% inhibition rate.

The field observations were conducted in August, coinciding with the dry season, which is characterized by low rainfall. Conversely, high rainfall and strong winds facilitate the spread of spores from infected to healthy leaves within the same plant or between neighboring plants (Novrizal & Adwanda, 2024). The low rainfall during the study period contributed to the reduced frequency and intensity of leaf spot infections. The nursery at PT. Sungai Rangit adheres to a planting distance of 90 cm x 78 cm in the main nursery phase. Inappropriate agronomic practices can hinder plant growth, induce stress, and compromise plant resistance to *Curvularia* sp. infections, thereby increasing susceptibility to the disease (Mahmud et al., 2024). Proper spacing between seedlings is essential to mitigating disease spread; a minimum polythene bag spacing of 90 cm is recommended (Wibowo et al., 2023). The current nursery layout aligns with these recommendations, suggesting that appropriate spacing has contributed to disease suppression in oil palm seedlings. Additionally, Priwiratama & Widiyatmoko (2022) identified fungal infections caused by *Curvularia* sp. as a primary factor in the occurrence of leaf spot in oil palm nurseries, reinforcing the importance of integrated disease management strategies.

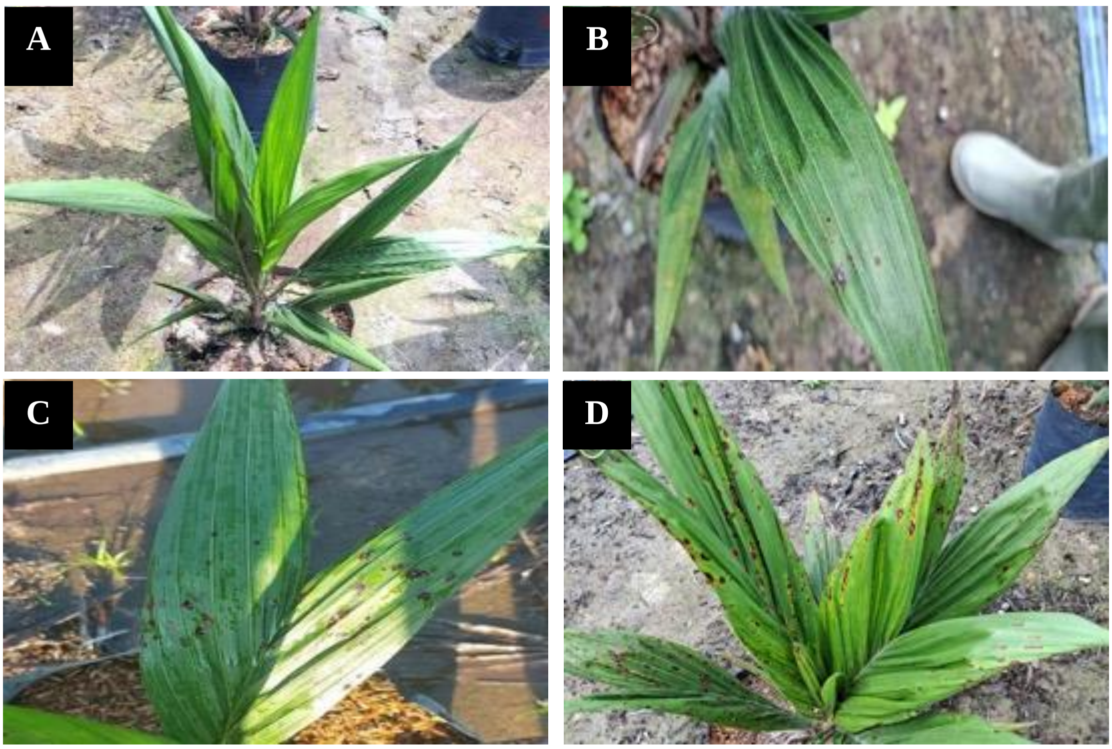


Figure 7. *Curvularia* sp. Infection on Palm Oil Seedling (a) Healthy, (b) Mild Damage, (c) Moderate Damage, (d) Severe Damage, (e) Extreme Damage.

Figure 7 illustrates the varying intensity of *Curvularia* sp. infection in the nursery area owned by PT. Sungai Rangit. The spread of Curvularia fungi occurs through its conidia, which can be dispersed by wind, rain splashes, irrigation water, and insects. In general, fungal infection occurs through penetration of the cuticle, stomata, or wounds on the plant tissue (Suganda & Wulandari, 2018). This rapid mode of transmission significantly accelerates the spread of Curvularia leaf spot disease. Figure 7a represents the initial symptoms of *Curvularia* sp. infection. If effective control measures are not implemented promptly, the disease can rapidly progress, leading to severe damage as depicted in Figure 7d. Figure 7e shows an oil palm seedling that has been severely infected by *Curvularia* sp. and is no longer viable for recovery.

The presence of Curvularia fungi requires serious attention from multiple stakeholders, not only due to its ability to cause disease in plants, thereby reducing productivity and economic value, but also because certain species, such as *C. lunata*, have been reported to be pathogenic or allergenic to humans and animals. This pathogenicity is attributed to the production of toxic compounds, namely brefeldin and curvularin, which pose potential health hazards (Halma et al., 2023). Given these detrimental effects, intensive and strategic control measures are essential to mitigate the impact of *Curvularia* sp. infections.

## Conclusion

This study highlights the presence of significant pests and diseases affecting oil palm (Elaeis guineensis) seedlings in PT. Sungai Rangit's nursery in Central Borneo. The key insect pests identified include the rhinoceros beetle (*Oryctes rhinoceros*), armyworm (*Spodoptera* sp.), bagworm (*Metisa plana*), and grasshopper (*Valanga* sp.). Additionally, the fungal pathogen *Curvularia* sp. was found to be a primary cause of leaf spot disease in seedlings. The observed of *Curvularia* sp. infection was 2.09%, classified as mild damage. The relatively low disease incidence is attributed to environmental conditions, cultural practices, and routine fungicide applications. The findings emphasize the importance of proactive pest and disease management strategies in oil palm nurseries. If left uncontrolled, these pests and pathogens can significantly impact seedling survival rates, ultimately reducing overall plantation productivity. Early detection, coupled with targeted control measures, is essential in minimizing losses and ensuring sustainable oil palm cultivation.

## Acknowledgments

The authors express their sincere gratitude to PT. Sungai Rangit for their invaluable support in facilitating this research. We extend our appreciation to Mr. Maulana, Field Quality Assurance (FQA) Assistant, for his guidance and assistance during field observations, and to Mr. Kris Sarjono for his supervision and expertise throughout the study. We also acknowledge the dedicated staff of PT. Sungai Rangit for their logistical support and for providing access to the nursery and plantation sites.

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