



Research Article

Exploration of Plant Disturbing Organisms (PDOs) in Trembesi (*Samanea saman*) Seedlings in Tectona Bukit Soeharto Seedlings

Eksplorasi Organisme Pengganggu Tanaman (Opt) pada Semai Trembesi (*Samanea saman*) di Persemaian Tectona Bukit Soeharto

Oshlifin Rucmana Saud^{1*}, Achmad Syarifudin¹, Muhammad Rafii Nur Fauzan¹, Andi Nugroho¹, Widia Sri Utami²

¹ Faculty of Forestry,
Universitas Mulawarman,
Samarinda, 75123, East
Kalimantan, Indonesia

² Faculty of Forestry,
Tanjungpura University,
Pontianak, 78115, West
Kalimantan, Indonesia

*email:
oshlifinas@fahatan.unmul.ac.id

Received: July 2025
Accepted: September 2025
Published: October 2025

p-ISSN: 2723-7974
e-ISSN: 2723-7966
doi: 10.52045/jca.v6i1.995

Website:
<https://ojs.unika.ac.id/index.php/faperta>

Abstract: The seedling phase is a critical stage in plant development, where the presence of plant-disturbing organisms (PDOs) can significantly reduce seedling quality and viability, particularly in rehabilitation species such as *Samanea saman* (Trembesi). This study aimed to analyze the intensity of pest and disease attacks, identify the types of PDOs involved, and describe the symptoms and signs of infestation observed in *S. saman* seedlings at the Tectona Nursery, KHDTK Bukit Soeharto, East Kalimantan. A simple random sampling method was applied to select 50 seedlings from a total population of 1,000 four-month-old individuals. Data collection was conducted through direct field observation of physical plant conditions, severity scoring, and documentation of symptoms and signs of biotic attack. The results showed that all sampled seedlings were affected, with an infestation intensity reaching 65.2%, classified as heavily infested. The observed symptoms included defoliation, foliar tissue loss (skeletonizing), leaf spots, leaf blight, and stem boring. Identified signs of attack included larvae from the order Lepidoptera and mealybug (Pseudococcidae) and aphids, which are suspected to be the primary agents of tissue damage. These findings underscore the importance of monitoring pest and disease populations and implementing ecologically based Integrated Pest Management (IPM) strategies tailored to the nursery microclimate. Technical training and coordinated IPM implementation are essential to enhance seedling resilience and support the success of tropical forest rehabilitation.

Keywords: *Samanea saman*, nursery, infestation intensity, symptoms and signs

Abstrak: Serangan organisme pengganggu tumbuhan (OPT) pada fase persemaian merupakan faktor krusial yang dapat menurunkan mutu dan viabilitas bibit, terutama pada spesies rehabilitasi seperti *Samanea saman* (Trembesi). Penelitian ini bertujuan untuk menganalisis tingkat serangan hama dan penyakit, mengidentifikasi jenis-jenis OPT, serta mendeskripsikan gejala dan tanda serangan pada semai *S. saman* di Persemaian Tectona, KHDTK Bukit Soeharto, Kalimantan Timur. Pengambilan sampel dilakukan secara acak sederhana terhadap 50 individu semai dari total populasi 1.000 semai berumur empat bulan. Data dikumpulkan melalui observasi langsung terhadap kondisi fisik tanaman, skoring tingkat serangan, serta pengumpulan dan identifikasi gejala dan tanda serangan. Hasil penelitian menunjukkan bahwa seluruh individu mengalami serangan dengan intensitas mencapai 65,2%, yang tergolong dalam kategori terserang berat. Gejala yang ditemukan meliputi rontok daun, kehilangan jaringan daun (skeletonizing), bercak daun, hawar daun, dan batang berlubang. Tanda serangan yang teridentifikasi mencakup larva dari ordo Lepidoptera kutu putih dan kutu daun, yang diduga sebagai agen utama penyebab kerusakan jaringan tanaman. Temuan ini menegaskan pentingnya monitoring OPT dan penerapan *Integrated Pest Management* (IPM) berbasis ekologi yang adaptif terhadap mikroklimat persemaian. Diperlukan pelatihan teknis dan implementasi terpadu untuk meningkatkan ketahanan semai serta mendukung rehabilitasi hutan tropis.

Kata kunci: *Samanea saman*, persemaian, intensitas serangan, gejala dan tanda

Citation:

Saud OR, Syarifudin A, Fauzan MRN, Nugroho A, Utami WS. 2025. Exploration of Plant Disturbing Organisms (PDOs) in Trembesi (*Samanea saman*) Seedlings in Tectona Bukit Soeharto Seedlings. *CELEBES Agricultural*. 6(1): 33-45. doi: 10.52045/jca.v6i1.995

INTRODUCTION

Land degradation caused by deforestation, mining activities, and land cover conversion has become an urgent ecological concern in tropical regions, including East Kalimantan ([Sudarmadji and Hartati, 2016](#); [Adhi et al., 2022](#)). To address this damage, landscape rehabilitation programs rely heavily on the availability of high-quality seedlings, the production of which is determined by effective and adaptive nursery management ([Cerqueira et al., 2022](#)). Nurseries function as propagation centers and serve as critical stages in ensuring the viability and initial resilience of seedlings against various biotic and abiotic stressors ([Pardi et al., 2023](#)). One of the commonly utilized species in rehabilitation and reforestation programs is *Samanea saman* (commonly known as rain tree), which is recognized for its fast growth, nitrogen-fixing ability, and tolerance to dry tropical environments ([Ow et al., 2019](#); [Aguirre-Morales et al., 2020](#)). Morphological advantages such as deep root systems and dense canopies make this species effective in controlling erosion and providing shade ([Burylo et al., 2012](#); [Zhou et al., 2022](#)). However, the success of *S. saman* utilization is strongly influenced by the quality of seedlings produced in nurseries, particularly during the seedling stage, which is vulnerable to attacks by plant pests and pathogens ([Abaurre et al., 2021](#); [Rita et al., 2022](#)).

The nursery phase is widely recognized as a critical stage in the plant life cycle, during which seedlings are highly susceptible to attacks by Plant Pest Organisms (OPT), such as insects, nematodes, and fungal pathogens. These biotic disturbances may result in decreased vigor, stunted growth, or even seedling death if early detection and timely control are not implemented ([Hidayati, 2018](#); [Sánchez et al., 2022](#)). In many tropical nursery sites, common cases such as leaf spot diseases and root rot have been recorded as major causes of high seedling mortality, followed by chewing and sucking insect infestations ([Krishnadas and Comita, 2018](#); [Cannon et al., 2020](#)). Unfortunately, most nursery managers still lack adequate monitoring and early response systems, especially for *S. saman* (rain tree), which remains underrepresented in pest and disease protection studies. Therefore, early identification of OPT presence and characteristics is a critical step in developing integrated control strategies adapted to local conditions.

In this context, the Tectona Nursery, located in the Bukit Soeharto area, holds strategic importance as a seedling source for forest rehabilitation programs in East Kalimantan. The site lies within a production forest area that has undergone severe degradation and is now one of the focal points for regional-scale ecological restoration ([Zainal et al., 2021](#); [Yuliadi et al., 2023](#)). Its microenvironment, characterized by high humidity, dense seedling populations, and exposure to tropical rainfall, creates favorable conditions for the proliferation of Plant Pest Organisms (OPT), which may disrupt seedling growth and survival ([Malik et al., 2018](#)). Although the nursery has been actively distributing various types of seedlings, information on the specific pests and diseases affecting *S. saman* seedlings at this location remains limited. In fact, delayed detection of such disturbances could lead to planting failure in the field and hinder the success of rehabilitation efforts.

This study aims to analyze the level of disease incidence in *S. saman* seedlings, explore the types of Plant Disturbing Organisms (PDOs) present in the Tectona Nursery within the

Kawasan Hutan Dengan Tujuan Khusus (KHDTK) of Bukit Soeharto, and identify the associated symptoms of infection. The findings from this exploration are expected to serve as a foundation for developing ecologically based control strategies that enhance nursery management, particularly in ensuring the production of high-quality seedlings that are resistant to biotic stress from the early growth stages. Furthermore, the results of this study have the potential to serve as a practical reference for nursery managers both in general contexts and specifically for *S. saman* in designing more adaptive, preventive, and efficient monitoring and sanitation management systems.

MATERIALS AND METHODS

This research was conducted at the Tectona Nursery, located within the Kawasan Hutan Dengan Tujuan Khusus (KHDTK) of Bukit Soeharto, specifically at Kilometer 54 on the Samarinda–Balikpapan main road. The study was carried out over a period of approximately two months, from May to June 2025. The research object consisted of four-month-old *S. saman* (rain tree) seedlings.

Data collection in this study was carried out using a stratified random sampling method, in which 50 individual *S. saman* (rain tree) seedlings were randomly selected from a total population of 1,000 seedlings located within the Tectona Nursery beds. To ensure representative sampling across the population, the sampling process was stratified based on three bed positions: the upper end, middle, and lower end of the nursery rows. The selected seedlings were gathered in a single container using seedling trays, sequentially labeled with plant stake labels, and individually observed in detail. Observations began by assessing the general condition of each seedling, categorizing them as healthy or showing symptoms of disease. Subsequently, a scoring system (Table 1) was applied to determine the severity of pest and disease attacks, as well as to identify the types of damage or infection observed.

Table 1. Scoring and classification criteria of seedlings affected by pests and diseases

Plant Condition	Score
Not Affected (NA) No visible symptoms; normal growth; intact, fresh green leaves.	0
Slightly Affected (SA) Few leaves affected; low intensity of symptoms on each affected leaf; some leaf fall.	1
Moderately Affected (MA) Moderate number of affected leaves and/or moderate symptom intensity; leaf fall or stem lesions.	2
Heavily Affected (HA) High number of affected leaves and/or severe symptoms; leaf fall; stem damage.	3
Severely Affected (SeA) Very high number of affected leaves and/or severe leaf fall; stem damage or stunted growth.	4

Plant Condition	Score
Dead Plant (DP)	5
Plant death due to pest or disease attack.	

Source: ([Mardji, 2003](#))

In addition, plant pests observed on *S. saman* seedlings were collected for further identification. The collection was not limited to sampled seedlings but also included individuals outside the sample set to ensure accurate identification of infestation agents. These additional collections were used solely for taxonomic purposes and did not affect the intensity calculations reported in this study. All collected data were recorded on tally sheets (Table 2), while visible symptoms and signs were preserved in labeled plastic sample bags for subsequent identification and documentation.

Table 2. Tally sheet for recording pest and disease observations on *Samanea saman* seedlings

No	Species	Sick		Score					Symptoms	Signs	Explanation
		Yes	Not	0	1	2	3	4	5		
1											
2											
3											
...											

The collected data were then processed and analyzed based on their relevance. The intensity of pest attacks on *S. saman* seedlings was analyzed using a formula proposed by Singh and Mishra (1992), which was later modified by [Mardji \(2000\)](#), as follows:

$$AI = \frac{X_1Y_1 + X_2Y_2 + X_3Y_3 + X_4Y_4 + X_5Y_5}{XY_5} \times 100\%$$

Where:

- AI = Attack Intensity (%)
- X = Total number of observed seedlings
- Y = Maximum severity score (in this case, 5)
- X₁ = Number of seedlings with slight infestation (score 1)
- X₂ = Number of seedlings with moderate infestation (score 2)
- X₃ = Number of seedlings with heavy infestation (score 3)
- X₄ = Number of seedlings with very heavy infestation (score 4)
- X₅ = Number of seedlings that died due to pest or disease attack (score 5)
- Y₁ = Severity weight for slight infestation (1)
- Y₂ = Severity weight for moderate infestation (2)
- Y₃ = Severity weight for heavy infestation (3)
- Y₄ = Severity weight for very heavy infestation (4)
- Y₅ = severity value for dead plants (5)

The results of the infestation intensity analysis were then interpreted using classification criteria adapted from [Mardji \(2003\)](#) to describe the overall condition of the seedlings as affected by pest and disease attacks. The classification criteria are presented in Table 3.

Table 3. Classification criteria for overall seedling condition based on infestation intensity

Infestation Intensity (%)	Seedling Condition
0 - 1	Healthy (H)
>1 - 25	Slightly Affected (SA)
>25 - 50	Moderately Affected (MA)
>50 - 75	Heavily Affected (HA)
>75 - 100	Severely Affected (SeA)

The data on symptoms and signs identified on *S. saman* (Trembesi) seedlings were systematically analyzed using Microsoft Excel to provide accurate and comprehensible information. All observational results were supplemented with visual documentation, including photographs of symptomatic plant parts, in order to enhance the validity of the data in the context of plant disease diagnostics. Subsequently, an analysis of the Attack Intensity (X) for each pest and disease will be conducted using the formula proposed by [Singh and Mishra \(1992\)](#), as follows:

$$\text{Intensity of pest and disease attacks (x)} = \frac{\text{Number of seedlings affected by pests and diseases (x)}}{\text{Total observed seedlings}} \times 100\%$$

RESULTS AND DISCUSSION

Based on observations of 50 *Samanea saman* (Trembesi) seedlings, all individuals exhibited symptoms of pest and disease infestation. The severity of the damage was indicated by scoring values that predominantly fell within categories 3 to 4, corresponding to the classifications of Slightly Affected (SA) to Severely Affected (SeA) (Figure 1). In other words, the majority of seedlings experienced significant damage to vegetative parts, potentially impairing their early growth and viability in the field. These findings were subsequently analyzed further to calculate the frequency of infestation, as presented in Table 4.

Table 4. Plant Condition, Damage Severity Scores, and Infestation Frequency

Family	Species	Lokal name	Total Plants	Score						Infestation Intensity (%)	Infestation Category
				0	1	2	3	4	5		
Fabaceae	<i>Samanea saman</i>	Trembesi	50	0	1	9	18	20	2	65.2	Heavily Affected

Based on field observations, the infestation intensity of pests and diseases in *S. saman* seedlings reached 65.2%, which was classified as heavily affected. This categorization was based on a visual scoring system that assessed symptom severity, in which the majority of seedlings received scores ranging from 3 to 4, indicating substantial damage to leaf tissues, stems, and root systems. [Utami and Ismanto \(2016\)](#), infestation intensities exceeding the 50% threshold represent

significant disturbances that may impair plant growth and survival. Visually, the observed *S. saman* seedlings exhibited severe defoliation as a predominant symptom. This condition is presumed to be caused by the activity of plant disturbing organisms, including both macro-organisms such as herbivorous insects and pathogenic microorganisms, which simultaneously attacked leaf and stem tissues, exacerbating the extent of morphological damage.

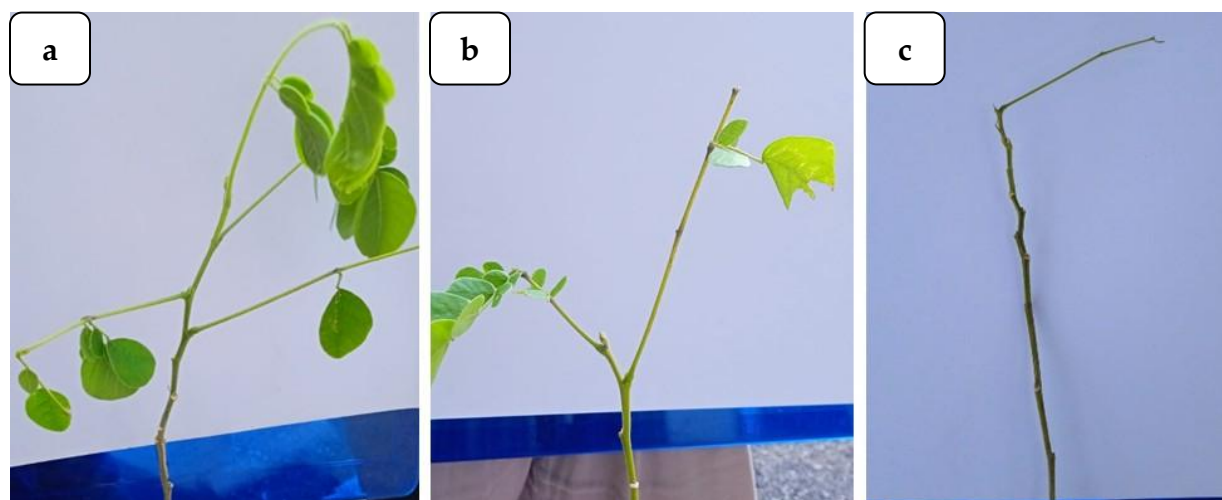


Figure 1. Severity levels of plant damage: (a) Score 3, (b) Score 4, and (c) Score 5.

Based on field observations, *S. saman* seedlings exhibited various symptoms of plant pest and disease infestation, including defoliation, necrotic leaf tissue loss, leaf spots, leaf blight, and stem perforation. These symptoms indicate physiological and morphological disruptions that may hinder seedling growth. Additionally, signs of pest presence, including Lepidopteran larvae and mealybugs, were observed. Lepidoptera and mealybugs are recognized as major pests of Fabaceae species, including *S. saman* (Bedford, 2013). These pests are suspected to contribute to the damage, although their roles as primary agents remain to be confirmed through further diagnostic analysis.

Table 5. Symptoms and Signs of Infestation Observed in *Samanea saman*

Family	Species	Local name (if Indonesian)	Symptoms	Signs
Fabaceae	<i>Samanea saman</i>	Trembesi	D, LTL, LS, LB, SP	Larvae (Lepidoptera) Mealybugs

Information: D (Defoliation), LTL (Leaf tissue loss), LS (Leaf spot), LB (Leaf blight), SP (Stem perforation).

Leaf defoliation (D) observed in *S. saman* seedlings generally indicates a physiological disorder caused by biotic stress, particularly due to the infestation of sap-sucking insects such as mealybug or foliar pathogens. Such attacks interfere with nutrient and water transport within the plant, leading to tissue weakening and resulting in premature leaf drop (Mondal, 2022; Koptur et al., 2023).

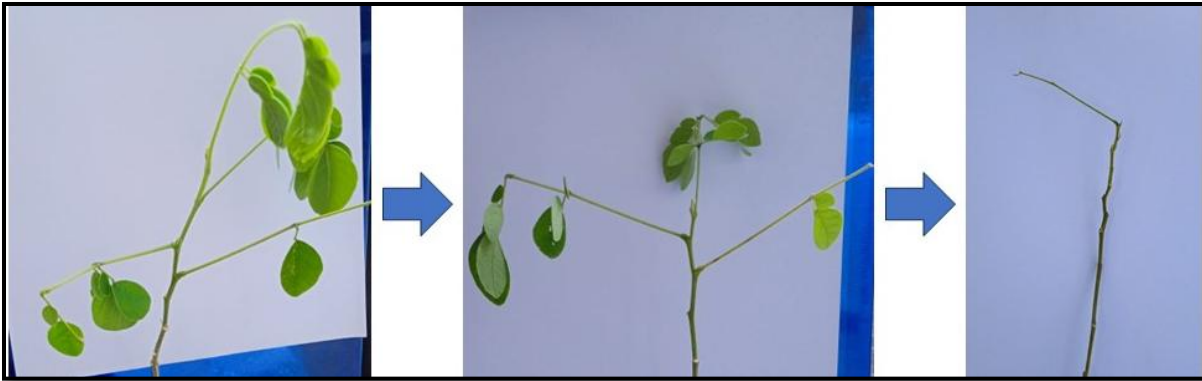


Figure 2. Leaf Defoliation in *Samanea saman* Seedlings

Leaf tissue loss (LTL) in *Samanea saman* seedlings is commonly caused by herbivorous activity, particularly from larvae of the orders Lepidoptera, Coleoptera, and Orthoptera, which consume the mesophyll tissue between the leaf epidermal layers. This type of damage, known as *skeletonizing*, results in the retention of only leaf veins due to the intensive feeding of foliar tissue. Such feeding behavior significantly reduces the plant's photosynthetic capacity and increases its susceptibility to opportunistic pathogens (González-Zurdo et al., 2016; Yamawo et al., 2019). Field observations confirmed the presence of larvae from the family Pieridae (Order Lepidoptera), actively feeding on leaf surfaces and creating irregular holes, which led to complete leaf loss in several seedling individuals.



Figure 3. Leaf Tissue Loss Caused by Lepidopteran Larvae

Leaf spot in *S. saman* seedlings are typically characterized by irregularly shaped necrotic areas, ranging in color from brown to dark brown. These lesions result from a complex interaction between sup-sucking insect, such as aphids, and microscopic pathogenic infections, particularly fungi belonging to the genera *Cercospora* spp. and *Colletotrichum* spp. Field observations

revealed the presence of mealybugs on seedling stems, while microscopic examination of leaf tissues confirmed aphid activity that damaged the leaf surface and caused orange to brownish discoloration. The occurrence of leaf spots is frequently exacerbated by high humidity and poor air circulation within the nursery environment, which together create a microclimate conducive to pathogen development and spread (Irawan et al., 2015; Wei et al., 2023). If left unmanaged, these infections may progress into leaf blight, a more advanced necrotic condition that spreads across the entire leaf surface, ultimately resulting in complete foliar tissue death. The primary causal agents of leaf blight have been reported to include fungal species of the genus *Phytophthora* and the bacterium *Pseudomonas syringae*, which invade plant tissues through wounds or stomatal openings, particularly under conditions of high humidity, intense rainfall, or waterlogged growing media (Panthee et al., 2024; Yang and Hong, 2020).

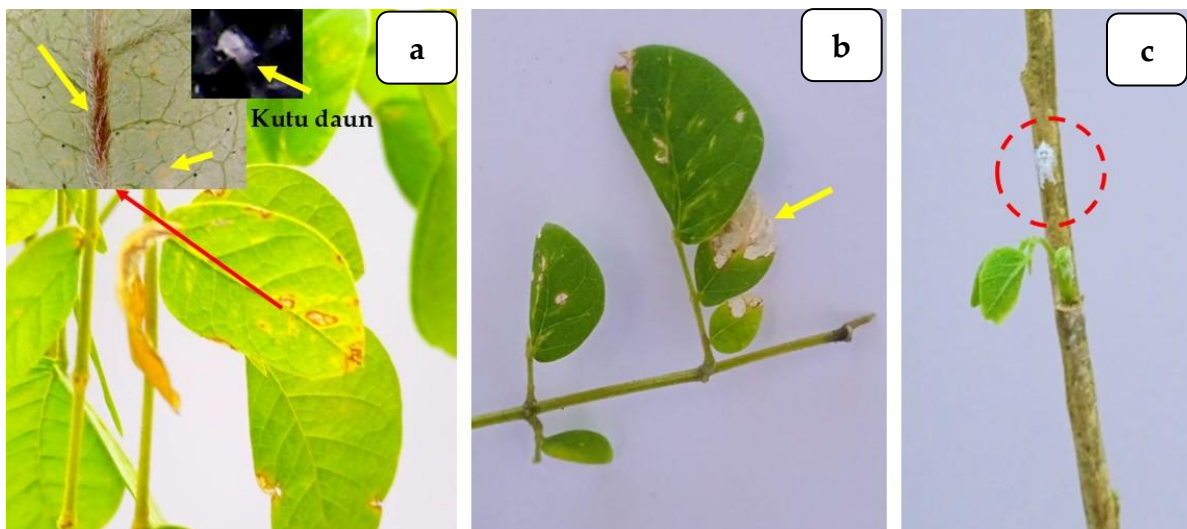


Figure 4. Pest Infestation in *S. saman* Seedlings: (a) Leaf Spot, (b) Leaf Blight, and (c) Mealybug

Stem perforation (SP) symptoms observed in *S. saman* seedlings are presumed to be caused by the boring activity of larvae from the orders Coleoptera or Lepidoptera, which penetrate the stem tissue through wounds or natural openings on the cortex surface. These larvae excavate longitudinal tunnels within the xylem tissue, disrupting the plant's vascular system, impairing the transport of water and nutrients, and weakening the stem's mechanical integrity (Dey, 2020; Khoo et al., 2023). Accumulated damage from such boring activity gradually leads to stem brittleness and, in severe cases, breakage of the seedling. Field observations identified small holes accompanied by characteristic wood-boring traces and the presence of fine powdery frass around the entry points, common indicators of stem borer infestation. The presence of stem borers during the nursery phase poses a critical threat to seedling viability prior to field transplantation. Therefore, early detection and integrated pest management strategies are essential to ensure the production of high-quality planting stock.

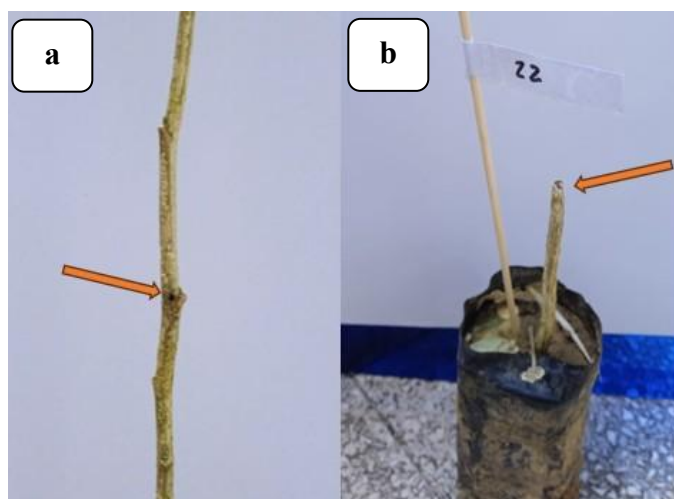


Figure 5. Symptoms of Stem Borer Infestation in *S. saman* Seedlings: (a) Stem perforation, (b) Stem breakage due to internal damage.

Based on observations of 50 seedlings, variations in the intensity of pest and disease attacks were recorded. Leaf defoliation occurred in 22 seedlings, leaf tissue loss in 44 seedlings, leaf spots in 36 seedlings, leaf blight in 5 seedlings, and stem perforation in 2 seedlings. The detailed results are presented in Table 6.

Table 6. Pest and Disease Attack Intensity (x) in *S. saman* Seedlings

Type of disease	Total Seedlings observed	Total attacks	Attack intensity (%)
Defoliation	50	22	44
Leaf Tissue Loss		44	88
Leaf Spot		36	72
Leaf Blight		5	10
Stem Peforation		2	4

The analysis of pest and disease intensity on 50 seedlings revealed variations in the severity of attacks. The highest incidence was recorded in leaf tissue loss (88%), followed by leaf spot (72%) and leaf fall (44%). In contrast, lower levels of damage were observed in leaf blight (10%) and stem perforation (4%). Overall, these results indicate that herbivory and foliar pathogens are the primary factors limiting seedling growth. Therefore, integrated control strategies, including routine monitoring, environmental sanitation, and the application of biological control agents, are required to minimize potential losses. The findings further suggest that herbivorous insects consuming leaf tissues and foliar pathogens responsible for leaf spots primarily cause damage. In general, this study underscores the importance of adopting integrated pest and disease management from the earliest stages of seedling development to reduce damage and ensure sustainable plant growth.

CONCLUSIONS

This study revealed that *S. saman* seedlings experienced a high level of pest and disease infestation (65.2%), indicating severe biotic stress. The main symptoms were leaf defoliation, tissue loss (skeletonizing), leaf spots, leaf blight, and stem perforation. Infestation was primarily caused by Lepidopteran larvae, aphids, and mealybugs, which are major agents of tissue damage. Among 50 seedlings observed, leaf tissue loss (88%) was the most prevalent, followed by leaf spots (72%), defoliation (44%), leaf blight (10%), and stem perforation (4%).

In light of these findings, it is recommended that pest and disease management in nurseries be conducted through an Integrated Pest Management (IPM) strategy. This approach should involve regular monitoring, control of humidity and bed aeration, the use of natural enemies, and the implementation of proper nursery sanitation practices. Furthermore, technical training for nursery personnel on the early identification of pest and disease symptoms is essential to prevent further losses and to ensure the availability of high-quality seedlings for forest and land rehabilitation programs.

ACKNOWLEDGMENT

The author gratefully acknowledges the support provided by all parties involved in the implementation of this research. Special thanks are extended to the manager of the Tectona Nursery in the Kawasan Hutan Dengan Tujuan Khusus (KHDTK) Bukit Soeharto and to the Pusat Rehabilitasi Hutan (Pusrehut), Mulawarman University, for their permission, provision of research facilities, and valuable technical assistance during field data collection. The author also wishes to express sincere appreciation to the Faculty of Forestry and Tropical Environment, Mulawarman University, for the academic and logistical support that contributed significantly to the successful completion of this study.

REFERENCES

- Abaurre, G.W., Saggin, O.J. & de Faria, S.M. 2021. Interaction of substrates and inoculants for *Samanea Saman* (Jacq.) Merr seedling production. *Floresta e Ambiente* 28(4), e20210046. <https://doi.org/10.1590/2179-8087-FLORAM-2021-0046>
- Adhi, Y.P., Dewi, I.G.S. & Turisno, B.E. 2022. Ecological Impacts and Socio-Legal Infrastructure as an Approach to Environmental Management in Ex-Mining Land Reclamation. *International Journal of Sustainable Development & Planning* 17. <https://doi.org/10.18280/ijstdp.170729>
- Aguirre-Morales, C.A., Thomas, E., Cardozo, C.I., Gutiérrez, J., Alcazar Caicedo, C., Moscoso Higueta, L.G., Becerra López-Lavalle, L.A. & González, M.A. 2020. Genetic diversity of the rain tree (*Albizia saman*) in Colombian seasonally dry tropical forest for informing conservation and restoration interventions. *Ecology and Evolution* 10, 1905–1916. <https://doi.org/10.1002/ece3.6005>
- Bedford, G.O. 2013. Biology and Management of Palm Dynastid Beetles: Recent Advances. *Annu. Rev. Entomol.* 58, 353–372. <https://doi.org/10.1146/annurev-ento-120710-100547>

- Burylo, M., Rey, F., Mathys, N. & Dutoit, T. 2012. Plant root traits affecting the resistance of soils to concentrated flow erosion. *Earth Surface Processes and Landforms* 37, 1463–1470. <https://doi.org/10.1002/esp.3248>
- Cannon, P.G., O'Brien, M.J., Yusah, K.M., Edwards, D.P. & Freckleton, R.P. 2020. Limited contributions of plant pathogens to density-dependent seedling mortality of mast fruiting Bornean trees. *Ecology and evolution* 10, 13154–13164. <https://doi.org/10.1002/ece3.6906>
- Cerqueira, A.F., Santos, A.S., de Oliveira Alencar, C., de Oliveira, G.S., Santos, C.S., Schilling, A.C., dos Santos, M.S., Dalmolin, A.C., Gaiotto, F.A. & Mielke, M.S. 2022. Landscape conservation and maternal environment affect genetic diversity and the physiological responses of *Euterpe edulis* (Arecaceae) progenies to light availability. *Environmental and Experimental Botany* 194, 104722. <https://doi.org/10.1016/j.envexpbot.2021.104722>
- da Fonseca, R.M. 2003. Functions of nurseries according to the staff: placing the child's care in the context of education. *Revista da Escola de Enfermagem da USP* 37, 25–34. <https://doi.org/10.1590/s0080-62342003000200004>
- Dey, S., 2020. Stem borers, an important yield reducing insect pest complex of rice in India: A review. *Journal of Entomology and Zoology Studies* 8, 786–789.
- González-Zurdo, P., Escudero, A., Nuñez, R. & Mediavilla, S. 2016. Losses of leaf area owing to herbivory and early senescence in three tree species along a winter temperature gradient. *International journal of biometeorology* 60, 1661–1674.
- Hidayati, N. 2018. Identifikasi Penyebab Penyakit Lodoh Pada Semai Kaliandra (*Calliandra Callothyrsus*). *Jurnal Penelitian Sosial dan Ekonomi Kehutanan* 12, 135–142. <https://doi.org/10.20886/jpth.2018.12.2.135-142>
- Irawan, A., Anggraeni, I. & Christita, M., 2015. Identification Causes Leaf Spot Disease in Cempaka (*Magnolia elegans* (Blume.) H.Keng) Seedling and Its Control Techniques. *j. wasian* 2, 87. <https://doi.org/10.20886/jwas.v2i2.843>
- Khoo, Y.W., Tan, H.T., Khaw, Y.S., Li, S.-F. & Chong, K.P. 2023. First report of *Neoscytalidium dimidiatum* causing stem canker on *Selenicereus megalanthus* in Malaysia. *Plant Disease* 107, 222. <https://doi.org/10.1094/PDIS-03-22-0566-PDN>
- Koptur, S., Primoli, A.S. & Pimienta, M.C. 2023. Defoliation in Perennial Plants: Predictable and Surprising Results in *Senna* spp. *Plants* 12, 587. <https://doi.org/10.3390/plants12030587>
- Krishnadas, M. & Comita, L.S. 2018. Influence of soil pathogens on early regeneration success of tropical trees varies between forest edge and interior. *Oecologia* 186, 259–268.
- Makarov Y.V. 2022. The role of the nursery in the prevention of child TB. *Kazan medical journal* 29, 507–513. <https://doi.org/10.17816/kazmj89651>
- Malik, M.T., Sahu, Z., Tariq, T., Khan, A.H., Ullah, H., Zainab, A. & Ammar, M. 2018. Impact of environmental variables on spore dispersal trend of *Fusarium mangiferae* causing mango malformation disease in Pakistan. *Pakistan Journal of Phytopathology* 30. <https://doi.org/10.33866/phytopathol.030.01.0448>
- Mardji, D. 2003. Identifikasi dan penanggulangan penyakit pada tanaman Kehutanan. Pelatihan Bidang Perlindungan Hutan di PT ITCI Kartika Utama, Samarinda.
- Mardji, D. 2000. Penuntun Praktikum Penyakit Hutan. Samarinda (ID): Fakultas Kehutanan Universitas Mulawarman.

- Mondal, M.M.A. 2022. Defoliation impacts on morpho-physiological attributes and yield of tomato: Defoliation effect on yield in tomato. *SAARC Journal of Agriculture* 20, 87–96. <https://doi.org/10.3329/sja.v20i1.60652>
- Ow, L.F., Ghosh, S. & Yusof, M.L.M. 2019. Growth of *Samanea saman*: Estimated cooling potential of this tree in an urban environment. *Urban Forestry & Urban Greening* 41, 264–271. <https://doi.org/10.1016/j.ufug.2019.03.021>
- Panthee, D.R., Pandey, A. & Paudel, R. 2024. Multiple Foliar Fungal Disease Management in Tomatoes: A Comprehensive Approach. *International Journal of Plant Biology* 15, 69–93. <https://doi.org/10.3390/ijpb15010007>
- Pardi, R., Venturella, G., Domina, G., Di Gristina, E., Cirilincione, F. & Gargano, M.L. 2023. Forest nurseries and the National Recovery and Resilience Plan: the case of Sicily and Apulia (Italy). *Italian Botanist* 15, 49–63. <https://doi.org/10.3897/italianbotanist.15.102133> <https://italianbotanist.pensoft.net>
- Rita, W.S., Suprpta, D.N., Swantara, I.M.D. & Sudana, I.M. 2022. Antifungal Activity of Phenolic Compounds From *Samanea saman* Leaves Against Stem Rot Disease on Dragon Fruits Caused by *Fusarium Solani*. *KnE Life Sciences* 621–635–621–635. <https://doi.org/DOI10.18502/kl.v7i3.11167>
- Sánchez, Á.S., Melchor, G.I.H. & Gutiérrez, F.S. 2022. Main Pests and Diseases in Tropical Forest Species in Nursery. In: Current and Emerging Challenges in the Diseases of Trees. Bellé, C., editor. London (GB): IntechOpen publishing.
- Singh, U.P. & Mishra, G.D. 1992. Effect of powdery mildew (*Erysiphe pisi*) on nodulation and nitrogenase activity in pea (*Pisum sativum*). *Plant pathology* 41, 262–264. <https://doi.org/10.1111/j.1365-3059.1992.tb02347.x>
- Sudarmadji, T. & Hartati, W. 2016. The process of rehabilitation of mined forest lands toward degraded forest ecosystem recovery in Kalimantan, Indonesia. *Biodiversitas Journal of Biological Diversity* 17. <https://doi.org/10.13057/biodiv/d170127>
- Utami, S. & Ismanto, A. 2016. Serangan hama defoliator pada bibit tanaman kehutanan. *Jurnal Hutan Pulau-Pulau Kecil* 1, 97–104. <https://doi.org/10.30598/jhppk.2016.1.2.97>
- Wei, T., Luo, M., Zhang, H., Jia, W., Zeng, Y. & Jiang, Y. 2023. First report of leaf spot disease associated with faba bean (*Vicia faba*) caused by *Pestalotiopsis rosea* in China. *Plant Disease* 107, 2885. <https://doi.org/10.1094/PDIS-12-22-2920-PDN>
- Yamawo, A., Ohsaki, H. & Cahill Jr, J.F. 2019. Damage to leaf veins suppresses root foraging precision. *American Journal of Botany* 106, 1126–1130. <https://doi.org/10.1002/ajb2.1338>
- Yang, X. & Hong, C. 2020. Biological control of *Phytophthora* blight by *Pseudomonas protegens* strain 14D5. *European Journal of Plant Pathology* 156, 591–601.
- Yuliadi, Y., Nugroho, Y., Suyanto, S. & Kissinger, K. 2023. Tingkat Keberhasilan Kegiatan Rehabilitas Daerah Aliran Sungai (Das) Di Pt Borneo Indobara Lokasi Desa Artainkecamatan Aranio Kabupaten Banjar Provinsi Kalimantan Selatan. *EnviroSciencetea* 19, 121–132. <http://dx.doi.org/10.20527/es.v19i1.15753>
- Zainal, N.F., Merous, N.H. & Khan, A.A. 2021. Comparison of Stumpage Value in Old and Young Recovered Primary Forest at FRIM Selangor Forest Park. *Journal Of Agrobiotechnology* 12, 8–17. <https://doi.org/10.37231/jab.2021.12.2.253>

Zhou, J., Fu, B., He, X., Zhou, M. & Chen, L. 2022. Plant morphology and distribution control runoff and erosion in semi-arid environments. *Catena* 211, 106022. <https://doi.org/10.1016/j.catena.2022.106022>