

Leaf blight and stem rot disease infection on eucalyptus (*Eucalyptus pellita*)

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ABSTRACT

Eucalyptus pellita is an important plant for the pulp and paper industry. During its growth and development process, there are factors that inhibit *Eucalyptus*, namely stem rot and leaf blight caused by *Ceratocystis* and *Cylindrocladium*. The purpose of this study was to determine the incidence and intensity of leaf blight and stem rot diseases caused by *Ceratocystis* and *Cylindrocladium*, as well as to identify the ecological conditions and disease distribution in the Baung Central Nursery and Sungai Beyuku Nursery areas. The observation method used was direct field observation with purposive sampling and interviews with representatives from the nursery division. Symptoms of stem rot caused by *Ceratocystis* are indicated by streaks or lines that appear as pale brown to blackish patches on the sapwood, which result in weakened and broken stems. Symptoms of leaf blight caused by *Cylindrocladium* include round or oval dark brown to blackish leaf spots, which in advanced stages spread to the underside of the leaf and turn black. This study concludes that disease incidence in Baung Central Nursery is dominated by leaf blight caused by *Ceratocystis*, while in Sungai Beyuku Nursery it is dominated by leaf blight caused by *Cylindrocladium*.

Keywords: *Ceratocystis*, *Cylindrocladium*, *Eucalyptus pellita*, leaf blight, Myrtaceae

INTRODUCTION

Industrial Plantation Forests (HTI) are production forest areas that apply intensive silvicultural practices to supply raw materials for the forestry industry, both timber and non-timber (Purnama Sari et al., 2020). The primary objective of industrial plantation forests is to produce raw materials that meet human needs. *Eucalyptus* species are among the most important fast-growing species for the pulp and paper industry (Sulichantini, 2016; Rosianty et al., 2024).

The genus *Eucalyptus* comprises several species, including *Eucalyptus pellita*, *E. urophylla*, *E. alba*, *E. grandis*, and *E. degluba*, each with distinct morphological characteristics. The broader eucalypt group consists of three genera (Angophora, Corymbia, and *Eucalyptus*) with the genus *Eucalyptus* further divided into eight subgenera: *Eudesmia*, *Symphyomyrtus*,

Eucalyptus, *Acerosae*, *Cruciformes*, *Alveolata*, *Cuboidea*, and *Idiogenes* (Hutapea et al., 2023).

Eucalyptus grows in regions with subtropical and tropical climates. This plant can thrive in shallow, rocky, moist, and swampy soils, as well as in areas periodically flooded, with soil fertility ranging from arid and barren to highly fertile lands (Rahayu et al., 2021). However, these diverse growing environments, particularly in moist conditions, can also favor the development of pathogens such as those causing stem rot in *Eucalyptus pellita* seedlings during the critical nursery stage (Arsensi, 2018). To mitigate these risks and improve plantation quality, advanced breeding strategies are being developed, including techniques such as top grafting applied to young seedlings to accelerate the selection and propagation of resilient genotypes (de Oliveira Castro et al., 2021).

Eucalyptus pellita plays an important ecological and economic role; its leaves can be

processed into essential oil. Essential oils, also known as volatile or ethereal oils, are natural plant extracts obtained from wood, leaves, seeds, flowers, or flower buds through distillation (Saputra, 2023). Moreover, eucalyptus contributes significantly to the environment by maintaining ecosystem balance and producing oxygen.

During plant growth and development, certain factors can hinder these processes; one is disease infection affecting parts of eucalyptus plants. Such diseases can significantly inhibit plant growth and development. *Ceratocystis* leaf blight is a major disease of eucalyptus that attacks the leaves. *Ceratocystis* wilt has become an important disease in *Eucalyptus* spp. cultivated in Brazil, China, and Vietnam, and has also been identified in *Eucalyptus* spp. in Thailand and Indonesia (Indrayadi et al., 2023).

In Indonesia, leaf blight caused by the pathogen *Ceratocystis* sp. has rapidly spread and developed in eucalyptus plantations. In addition to leaf blight, which reduces productivity and yield, another important disease infects the stem of eucalyptus plants, *Cylindrocladium* stem rot, which attacks the bark tissues. Symptoms of *Cylindrocladium* infection on eucalyptus include leaf spots and shoot blight that spread upward from the tree base (Kurniawan et al., 2024). This study aimed to identify the causal agents of leaf blight and stem rot diseases on eucalyptus plants in several nurseries of PT. Bumi Andalas Permai.

MATERIALS AND METHODS

The survey locations and observation plots were determined using a purposive sampling method applied at two sites: Baung Central Nursery (50 ha) and Sungai Beyuku Nursery (5 ha). Sampling was specifically focused on areas showing visual symptoms of pathogen infection to ensure a representative assessment of the disease in the field. Within each nursery, observation plots were established in a diagonal X-pattern, comprising 10 representative sampling points. Selection criteria were based on the health status of *Eucalyptus pellita* seedlings, encompassing healthy plants, symptomatic plants (displaying leaf spots or stem lesions), and dead seedlings. All seedlings within the designated

observation blocks were thoroughly examined to calculate disease incidence and intensity. Observations were conducted across different growth stages, including 120-day-old seedlings in open areas and 45-day-old seedlings in shading areas, to provide a comprehensive overview of disease development throughout various developmental phases.

Determining Survey Location and Observation Plots

The survey locations were determined using a purposive sampling method, conducted at the Baung Central Nursery and the Sungai Beyuku Nursery. Observation plots were established in a diagonal “X” pattern, with ten samples representing each nursery. In each nursery, the incidence and severity of the disease were recorded within the observation blocks. All *Eucalyptus pellita* plants in each nursery were examined, and the geographic coordinates of each plant were recorded to determine the spatial distribution pattern of the disease in the field. The level of plant damage was assessed, and damage scores were assigned accordingly. Symptoms of *Ceratocystis* leaf blight included plant wilting, stem rot, and dark necrotic lesions on leaf surfaces.

Isolation and Identification of Diseases

Stem and leaf samples from diseased plants collected in the field were brought to the laboratory for examination. Fungal pathogens showing *Ceratocystis* symptoms were isolated from discolored wood and leaf tissues. The samples were surface-sterilized with 70% ethanol for 30 seconds and 1% NaOCl for 2 minutes. Small sections (6×6 mm) taken from the margins of the discolored areas were placed on malt extract agar (MEA) supplemented with 50 µg/ml streptomycin in Petri dishes. Other surface-sterilized wood pieces were sandwiched between carrot slices to serve as bait for *Ceratocystis* spp. (Safitri et al., 2025). Meanwhile, samples showing *Cylindrocladium* disease symptoms were not cultured on media but scraped from infected tissues and directly observed under a microscope for pathogen characterization.

The initial identification of *Ceratocystis* isolates was based on the morphological

characteristics of both the teleomorph and anamorph stages. Isolates were characterized from two-week-old cultures grown on 2% MEA. One hundred measurements of teleomorphic and anamorphic structures from each representative isolate were taken using an Olympus microscope equipped with an OptiLab camera system. The mean and standard deviation (SD) of all measurements were calculated and presented as mean \pm SD.

Incidence of Disease Attack

The incidence of disease attack in the field was determined by calculating the number of diseased plants divided by the total number of plants observed in each observation block.

$$P = \frac{A}{B} \times 100\%$$

P = Percentage of disease attack

A = Number of diseased plants

B = Total number of observed plants

Disease Attack Intensity

The intensity or severity of a plant disease could be assessed based on the symptoms observed in the field (Table 1), using the following calculation formula.

$$KP = \frac{\sum (ni \times vi)}{N \times V} \times 100\%$$

KP = Disease severity (%)

ni = Number of plants or plant parts at the score of -i

vi = Score of plant damage

N = Number of plants or plant parts observed

V = Highest damage score

Table 1. Scoring criteria for disease attack intensity

Score	Observation Criteria
0	Healthy plants with no symptoms
1	Plants affected by leaf blight and stem rot range from 1-25%
2	Plants affected by leaf blight and stem rot range from 25.1-50%
3	Plants affected by leaf blight and stem rot range from 50.1-75%
4	Plants affected by leaf blight and stem rot range from 75.1-100%

RESULTS

Observations at the Baung Central Nursery were conducted in two areas: seedlings aged 120 days in the open area and 45 days in the shading area. Fungi belonging to the genus *Ceratocystis* were consistently isolated from wood and leaves of diseased plants on MEA and carrot slice media. The *Ceratocystis* isolates from stems and leaves displayed typical morphological characteristics of *Ceratocystis* spp., forming distinctive olive-green colonies with a characteristic banana-like odor. The isolates produced globose to subglobose ascospores with long necks and divergent ostiolar hyphae at their apices. Both teleomorphic and anamorphic structures developed within two weeks on MEA culture. Two isolates from stems (CEB1) and leaves (CED1) were described; both possessed ascospores ($3.7\text{--}6.8 \times 2.9\text{--}4.8 \mu\text{m}$), cylindrical conidia ($13.8\text{--}24.7 \times 3.9\text{--}4.7 \mu\text{m}$), and chlamydospores ($10.8\text{--}15.8 \times 6.6\text{--}10.7 \mu\text{m}$). Additionally, both isolates produced doliform (barrel-shaped) conidia ($7.9\text{--}9.9 \times 5.7\text{--}7.9 \mu\text{m}$) arranged in chains (Figure 2).

The open area had a moderately fertile growing medium with a crumbly texture, consisting of a mixture of cocopeat and rice husk charcoal. In contrast, the shading area had a coarser growing medium with a sandy texture (Table 2).

Table 2. Nursery description

Nursery Description	Baung Nursery	Central	Nursery Sungai Beyuku
Location	2, 73192° S, 105,29354° E	S,	2,73838° S, 105,30237° E
Land area	50± ha.		5 ha 1± mont.
Planting distance	12x12 (Stool plant)		
Pesticide	Insecticide, Fungicide, Bactericide.	and	Insecticide, Fungicide, and Bactericide. Dolomite, CRF, TSP.
Fertilization	NPK and CRF.		Dolomit, CRF, TSP.
Irrigation	Boom Sprayer.		Sprayer Manual

Symptoms and Disease Identification in Plants

Symptoms of *Ceratocystis* leaf blight were characterized by irregularly shaped spots with uneven edges, brown to black in color, and surrounded by a yellow margin or halo on the

upper leaf surface (Figure 1a–b). In some cases, infection leads to leaf tip necrosis, followed by the drying and complete deterioration of leaf tissues. Symptoms of *Ceratocystis* stem rot appear as faint brown linear lesions on the lower, middle, or upper parts of Eucalyptus seedlings (Figure 1c). As the disease progresses, these lesions darken, and severe infections could cause stem weakening and breakage (Figure 1d). Microscopic observations of infected spots and lesions in several cases revealed the formation of perithecia (Figure 2d).

Symptoms of *Cylindrocladium* leaf blight was characterized by the appearance of small, light brown to dull greenish spots on the leaf surface (Figure 3a). As the disease progresses, the spots enlarge, turning dark brown to black, sometimes surrounded by a yellowish halo. Under severe infection, the lesions coalesce, forming extensive necrotic areas across the leaf surface. Severely infected leaves dry out, curl, and fall prematurely.

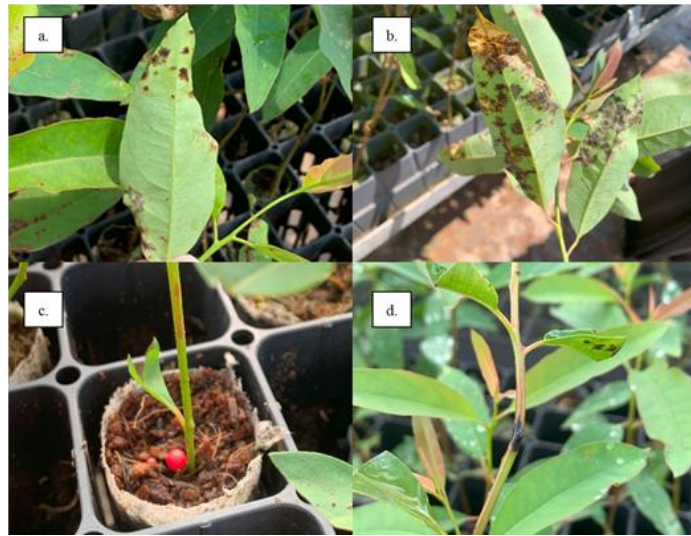


Figure 1. Leaf blight symptoms and stem rot *Ceratocystis*. a-b, leaf blight symptoms *Ceratocystis* on Eucalyptus. c-d, stem rot *Ceratocystis*.

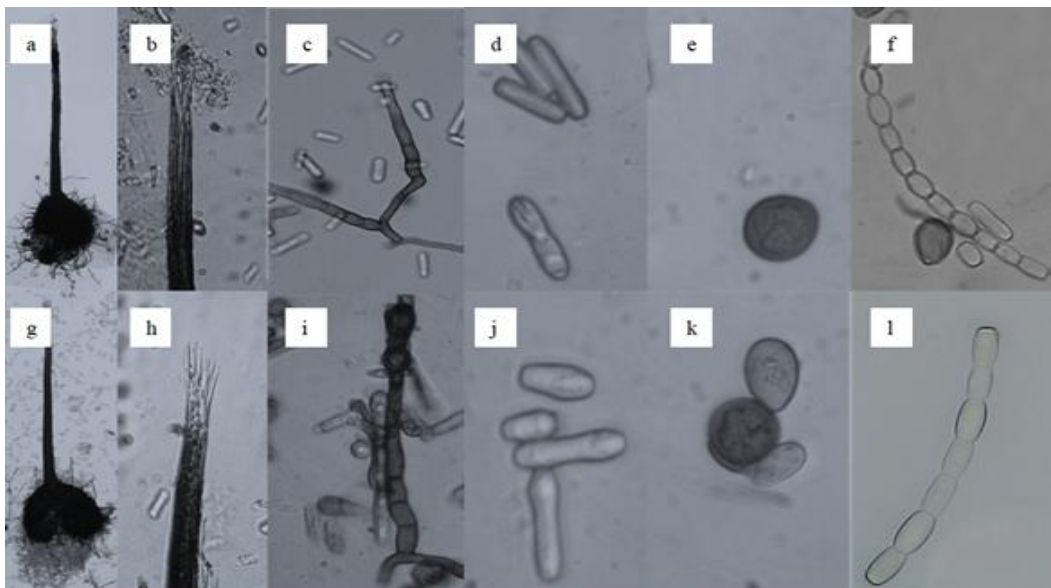


Figure 2. Microscopic characteristics of isolates CEB1 and CED1. a & g. Perithecium; b & h. Ostiolar hiphae; c & i. Phialides; d & j. Conidia cylinders; e & k. Chlamydozoospores; f & l. Doliform conidia.

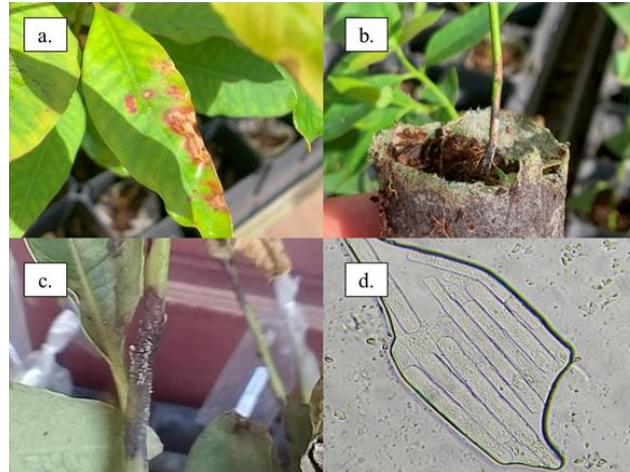


Figure 3. Leaf blight symptoms and stem rot *Cyindrocladium*. a. Leaf blight symptoms, b. Basal stem rot, c. Branch base rot, d. Conidia of *Cyindrocladium* sp.

Cyindrocladium stem rot on *Eucalyptus* seedlings was indicated by dark brown to black necrotic lesions at the base or on young stems. The cortex and cambium tissues decay and become dark brown. When peeled, the internal tissues appear soft and darker in color (Figures 3b–c). The infection may spread from the roots to the stem base. The roots appear decayed, brown, and fragile. *Cyindrocladium* produces cylindrical conidia on septate conidiophores (Figure 2d).

Disease Incidence and Intensity

The observation results indicate that the Central Baung Nursery has poorer seedling health conditions compared to the Sungai Beyuku Nursery, primarily due to severe leaf blight infections caused by *Ceratocystis* sp. In contrast, the Sungai Beyuku Nursery shows a higher level of seedling health and milder disease incidence, with only a few cases of leaf blight caused by *Cyindrocladium* sp.

Based on the data presented in the table, the health condition of *Eucalyptus pellita* seedlings at the two nursery locations—Central Baung Nursery and Sungai Beyuku Nursery—shows a marked difference in both growth performance and disease incidence. At Central Baung Nursery, 70% of the seedlings were classified as healthy, while 10% were dead. This indicates that approximately 20% of the seedlings exhibited disease symptoms but had not yet died. The diseases identified at this location included stem rot and leaf blight, both caused by pathogenic fungi, namely *Ceratocystis* sp. and

Cyindrocladium sp. Among these diseases, leaf blight caused by *Ceratocystis* sp. showed the highest level of infection, with an incidence rate of 23.86% and an intensity of 53.1%, indicating that the disease was widespread and caused severe damage to the seedling foliage. In contrast, stem rot caused by *Ceratocystis* sp. showed much lower levels of infection and severity, with incidence and intensity values of only 6.14%. Diseases caused by *Cyindrocladium* sp.—both stem rot and leaf blight—had very low incidence and intensity rates, each below 5%. These findings suggest that *Ceratocystis* sp., particularly the pathogen responsible for leaf blight, was the primary disease agent contributing to reduced seedling quality at Central Baung Nursery (Table 3).

In contrast, the condition of seedlings at the Sungai Beyuku Nursery was relatively better than at Central Baung. The percentage of healthy seedlings reached 84.1%, while dead seedlings accounted for only 5%, indicating a more optimal nursery environment and possibly a better disease management system. At this site, no infection by *Ceratocystis* sp. was detected on either stems or leaves (0% incidence and intensity). However, a mild infection by *Cyindrocladium* sp. was observed, with stem rot showing an incidence of 0.8% and an intensity of 1%, and leaf blight showing an incidence of 15.1% and an intensity of 17%. Nevertheless, the overall level of infection remained within the low to moderate range and did not significantly affect seedling survival.

Table 3. Percentage of incidence and intensity of leaf blight and stem rot diseases of *Ceratocystis* sp. and *Cylindrocladium* sp.

Nursery	Species	Healthy seeds	Dead seeds	Disease	Incidence	Intensity
Central Baung Nursery	<i>Eucalyptus pellita</i>	70%	10%	<i>Ceratocystis</i> sp. stem rot.	6.14%	6.14%
				<i>Ceratocystis</i> sp. leaf blight.	23.86%	53.1%
				<i>Cylindrocladium</i> sp. stem rot.	0.08%	0.07
				<i>Cylindrocladium</i> sp. leaf blight.	4.68%	3%
Nursery Sungai Beyuku	<i>Eucalyptus pellita</i>	84.1%	5%	<i>Ceratocystis</i> sp. stem rot.	0%	0%
				<i>Ceratocystis</i> sp. leaf blight.	0%	0%
				<i>Cylindrocladium</i> sp. stem rot.	0.8%	1%
				<i>Cylindrocladium</i> sp. leaf blight.	15.1%	17%

DISCUSSION

Ogan Komering Ilir Regency, South Sumatra, in July 2024. The study began with a field survey to identify disease symptoms on *Eucalyptus* plants in the plantation area, complementing previous taxonomic and health assessments of the species such as those conducted by Rosianty (2021) regarding the identification of *Eucalyptus pellita* F. Muell. The observed symptoms were then further examined to determine the pathogenic species involved. The identification revealed two major diseases: leaf blight caused by *Ceratocystis* sp. and stem rot caused by *Cylindrocladium* sp. Identification was supported by morphological observations and the distinctive characteristics of each pathogen, aligning with the systematic approach to identifying forest plantation health issues in the region. Furthermore, the identification of *Ceratocystis* species is increasingly supported by an understanding of their complex genetic and reproductive mechanisms, including inheritance patterns observed in self-fertile crosses of closely related species within the genus (Van der Walt et al., 2023).

Morphologically, *Cylindrocladium* sp. exhibits non-septate, hyaline (transparent) hyphae and produces small, cylindrical conidia. Its conidiophores are branched and terminate in phialides that generate long, smooth conidia (Di et al., 2024). In contrast, *Ceratocystis* sp. possesses septate hyphae and produces oval to spherical conidia on conidiophores. *Ceratocystis* wilt is recognized as one of the most significant

diseases affecting *Eucalyptus pellita* (Roux et al., 2020). Specifically in South Sumatra, this pathogen has been identified as a critical cause of wilting and deadly disease in *Eucalyptus* plantations, posing a major threat to forest health and productivity in the region (Pratama et al., 2023).

Generally, *Ceratocystis* sp. infections appear on both leaves and stems, causing leaf blight and stem rot. Early symptoms of leaf blight occur on the lower leaf surface as irregular dark brown to blackish spots. As the disease progresses, the lesions spread to the upper surface, forming translucent spots that mirror those on the underside. The severity and spread of such infections can be influenced by the physical properties of *Eucalyptus pellita* F. Muell., which have been shown to vary significantly based on the tree's provenance and sampling position (Yuniarti & Nirsatmanto, 2018). Without timely control through pesticide application and proper management practices, the disease can spread to neighboring plants and cause more extensive damage (Pratama et al., 2025).

Observations were conducted at Baung Central Nursery, located in Sungai Baung District, Ogan Komering Ilir Regency, South Sumatra, in July 2024. The study began with a field survey to identify disease symptoms on *Eucalyptus pellita* F. Muell. plants, a species whose early root development and growth performance at the nursery stage have been documented as being influenced by propagation methods, such as seeds or stem cuttings (Hassan et al., 2021). This identification aligns with

previous health and taxonomic assessments of *E. pellita* in industrial forest plantations in the region (Rosianty et al., 2021). The observed symptoms were then further examined to determine the pathogenic species involved. The identification revealed two major diseases: leaf blight caused by *Ceratocystis* sp. and stem rot caused by *Cylindrocladium* sp. Morphologically, *Cylindrocladium* sp. produces white to cream mycelia with branched hyphae and cylindrical to nearly globose conidiophores, which may arise from the mycelium or other infected plant tissues. Its conidia are typically oval with tapering ends, matching the taxonomic markers and pathogenic impact of this genus on *Eucalyptus* species globally (Crous et al., 2021).

Infection by *Cylindrocladium* sp. results in stem and root rot, premature leaf yellowing and defoliation, stunted growth, and the appearance of lesions on *E. pellita* leaves. The taxonomic complexity of this genus, often associated with the sexual state *Calonectria*, highlights its diverse morphological and phylogenetic characteristics which contribute to its broad host range and environmental adaptability (Chen et al., 2018).

Observations revealed differences in disease severity between two nurseries, Baung Central Nursery and Sungai Beyuku Nursery. At Baung Central Nursery, leaf blight caused by *Ceratocystis* sp. was more severe than at Sungai Beyuku, whereas stem rot caused by *Cylindrocladium* sp. was more severe at Sungai Beyuku. However, leaf blight caused by *Cylindrocladium* sp. showed higher incidence at Baung than at Sungai Beyuku. Beyond *Eucalyptus*, this pathogen also causes serious damage to *Acacia mangium*, *A. auriculiformis*, and their hybrids, exhibiting aggressive pathogenic mechanisms that, in severe cases, can lead to complete plant death (Rodas et al., 2005).

Such infections negatively affect productivity, as *A. mangium* and *E. pellita* are widely used in the pulp, paper, particle board, crate, and wood chip industries. The productivity of *Eucalyptus pellita* in Sumatra is heavily influenced by site variables, legacy effects from previous *Acacia mangium* rotations, and nutrient management, which are critical for guiding sustainable plantation management (Hardiyanto et al., 2021).

Ceratocystis sp. can infect through wounds and spread via root contact between diseased and healthy plants, as well as through maintenance and pruning activities (Hidayat et al., 2024). Therefore, leaf blight and stem rot caused by *Cylindrocladium* sp. represent significant threats to the growth and development of *E. pellita*, potentially undermining the yield targets and site-specific management strategies essential for these industrial plantations.

There are various factors influencing the development of diseases caused by *Ceratocystis* sp. and *Cylindrocladium* sp., which can generally be classified into abiotic and biotic factors. Abiotic factors are external elements that support disease growth and dissemination, including light intensity, temperature, air humidity, soil acidity, soil gas composition, and nutrient availability (Nursanti et al., 2022). These environmental dynamics are increasingly influenced by broader climate change patterns, which have been shown to impact plant productivity and create conditions conducive to pathogen outbreaks (Rusmayadi et al., 2024). Meanwhile, biotic factors involve the influence of other organisms that act as disease agents, such as fungi, bacteria, viruses, and nematodes. These two types of factors interact and jointly determine the severity of plant diseases, as pathogenic organisms from the biotic factors require specific environmental conditions—such as suitable temperature and humidity—to grow and develop optimally.

CONCLUSION

This study concludes that leaf blight and stem rot are the major constraints to the growth of *Eucalyptus pellita* in Baung Central Nursery and Sungai Beyuku Nursery, caused by *Ceratocystis* sp. and *Cylindrocladium* sp. In Baung Central Nursery, infection was dominated by *Ceratocystis* sp. leaf blight with an incidence of 23.86% and severity of 53.1%, while in Sungai Beyuku Nursery, *Cylindrocladium* sp. leaf blight predominated with an incidence of 15.1% and severity of 17%. The main symptoms included dark leaf spots and stem decay, leading to stem weakening and breakage. Disease development was influenced by abiotic factors (such as temperature, humidity, and soil pH) and biotic

factors (pathogenic organisms). Integrated management through environmental monitoring, sanitation, and proper fungicide application is required to suppress the spread of these diseases.

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