JUATIKA
JURNAL AGRONOMI TANAMAN TROPIKA
VOL. 8 No. 3 September 2026

DOI :https://doi.org/10.36378/juatika.v8i3.5747
eissn 2656-1727
pissn 2684-785X
pages : 788 – 795

REVIEW ARTICLE Open Access

Causing Pathogens and Level of Attack of Leaf Spot Disease in The Main Palm Oil (*Elaeis guineensis* Jacq.) Nursery in North Labuhanbatu

Aycel Dilosa Ginting[1], Muhammad Yusuf Dibisono[1,*], Guntoro[1]

Abstract

Leaf spot disease is of constraint in oil palm nurseries because it can reduce quality and inhibit seedling growth of seedlings. This study aims to identify the pathogen causing leaf spot disease and determine the percentage and intensity of attacks in the main oil palm nurseries owned by the community in North Labuhanbatu Regency. The study used survey methods and purposive sampling in Kualuh Hulu, Kualuh Selatan, and NA IX-X districts. Symptomatic leaf samples were isolated on Potato Dextrose Agar (PDA) media and identified based on macroscopic and microscopic morphological characteristics. The results showed that Curvularia sp. is the pathogen causing leaf spot disease, while Alternaria sp. and Aureobasidium sp. are associated fungi. The percentage of attacks increased in the three districts, respectively, from 19.30% to 26.31%, 17.33% to 23.66%, and 29.57% to 35.94%. Attack intensity increased from 8.21% to 11.15%, 7.46% to 10.60%, and 13.68% to 16.46%. NA IX-X showed the highest attack rate. The results can serve as a basis for monitoring leaf spot disease in oil palm nurseries.

Keywords: Disease Epidemiology, *Elaeis guineensis* Jacq., Pathogenic Fungi, Phytopathology, Seedling Health

1. Introduction

Oil palm (*Elaeis guineensis* Jacq.) is a strategic plantation commodity that contributes significantly to the Indonesian economy. According to the 2023 Indonesian Palm Oil Statistics, oil palm plantations reached 15.95 million hectares, with crude palm oil (CPO) production reaching 48.29 million tons and export value reaching USD 26.33 billion (BPS, 2023). This phenomenon demonstrates the crucial role oil palm plays in maintaining national economic stability, and successful cultivation relies heavily on high-quality nurseries.

In oil palm nurseries, serious problems are encountered, including disease attacks during the early growth phase. Leaf spot disease is one of the most common problems encountered in oil palm nurseries. This problem causes damage to the seedling leaves, stunting growth and reducing seedling quality. This condition can increase seedling mortality and extend the nursery period before plants are ready for transplanting into the field. (Cameron et al., 2025) reported that leaf spot disease caused by Curvularia sp. can reach an attack percentage of 93.29% with an attack intensity of 47.13%. This condition can result in increased seedling mortality and extend the nursery period before plants are ready to be transplanted into the field.

Leaf spot disease in oil palms is caused by infection with pathogenic fungi such as *Curvularia* spp. and *Drechslera* spp. Initial symptoms are characterized by the appearance of yellow spots on the leaves, which then develop brown and enlarge until they cause leaf tissue necrosis. Environmental conditions such as high humidity and rainfall, as well as cultivation factors such as plant density and nursery sanitation, influence disease development. Plant pathology theory explains that disease severity is influenced by the interaction among the host, pathogen, and environment, known as the disease triangle. Defitri (2021) explains that leaf spot symptoms can develop into irregular tissue damage and cause a significant decline in leaf function.

Research on leaf spot disease in oil palms has been

*Correspondence: myusuf_dibisono@itsi.ac.id
1 Institut Teknologi Sawit Indonesia - Jalan Willem Iskandar, Kecamatan Percut Sei Tuan, Kabupaten Deli Serdang, Sumatera Utara 20371, Indonesia

extensive but remains limited to aspects of control and large-scale plantations. Studies that focus on identifying the type of disease and the causative pathogen in community-owned oil palm nurseries in North Labuhanbatu Regency are still very limited. According to Wibowo et al. (2023), leaf spot disease, which is mainly caused by leaf spots, often attacks oil palms in the early growth phase and, if not properly controlled, can cause plant death. In contrast to previous studies that focused more on disease control or were conducted at specific nursery locations, this study focuses on identifying the pathogen causing leaf spot disease through macroscopic and microscopic morphological characteristics as well as measuring the percentage and intensity of attacks in the main community-owned oil palm nurseries in three sub-districts in North Labuhanbatu Regency, namely Kualuh Hulu, Kualuh Selatan, and NA IX-X. Thus, this study is expected to provide information on the types of pathogens and the level of leaf spot disease attack in community nurseries, where information has previously been limited.

This study aims to identify the types of leaf spot diseases found in primary oil palm nurseries in community plantations in North Labuhanbatu Regency and to identify the causative pathogens through morphological and microscopic laboratory observations. The results are expected to provide scientific information regarding disease conditions in oil palm nurseries and serve as a basis for developing further research on more effective leaf spot disease control strategies.

2. Material and Methods

This research method was carried out at the oil palm (Elaeis guineensis Jacq.) nursery owned by the community in North Labuhanbatu Regency, North Sumatra Province, which includes the Districts of Kualuh Hulu, Kualuh Selatan, and Marbau, with geographical conditions ranging from 1°58'–2°50' North Latitude and 99°25'–100°05' East Longitude, and has an altitude of around 0–700 meters above sea level (masl). The research activity was then continued with analysis at the Laboratory of the Indonesian Palm Oil Technology Institute from February to April 2026.

The research used a field and laboratory survey approach with purposive sampling to determine plant samples infected with leaf spot disease (Hutagalung & Noer, 2025). Samples were taken from 6–12-month-old seedlings during the main nursery phase, then labeled, documented, and recorded using GPS coordinates before being stored at low temperatures to maintain tissue and pathogen conditions. The data obtained were analyzed quantitatively to calculate the percentage and intensity of disease attacks and qualitatively to describe the symptoms and characteristics of the disease.(Andersen et al., 2024)

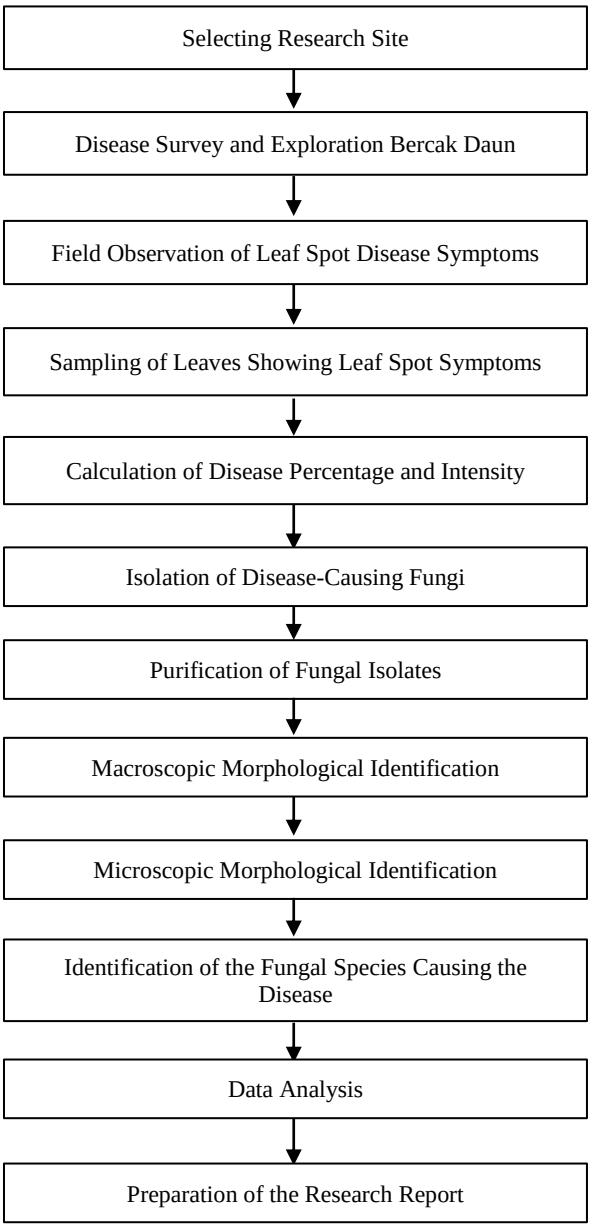

Figure 1. Research flow diagram

In the laboratory stage, sterilization of tools and materials was carried out using dry, flame, and surface sterilization methods with 70% alcohol and 1% NaOCl, then continued with isolation of fungi from infected leaf tissue using Potato Dextrose Agar (PDA) media that had been sterilized in an autoclave. According to Walida et al. (2024), PDA media is used to isolate pathogens that cause leaf spot disease. Symptomatic leaf pieces were placed on PDA media and incubated at 25°C for 2–7 days. Pathogen identification was carried out through macroscopic and microscopic observations using wet preparations with lactophenol blue and a binocular microscope (Olympus cx 23) at 40x magnification, then matched with the literature (Barnett & Hunter, 1998)and (Watanabe, 2002). The software used in this study included Microsoft Word for

preparing reports and Microsoft Excel for data processing, calculating the percentage of attacks and attack intensity, and presenting data in tables and graphs.(Manik et al., 2016)

Observation parameters included disease symptoms in the field, the percentage of attacks (PS), the intensity of attacks (IS), and the morphological characteristics of the fungus such as the color and shape of the hyphae and the shape of the conidia. The percentage of attacks was calculated using the formula PS = n/b × 100% (Suharti et al., 2011), while the intensity of attacks was calculated based on the scoring of the level of plant damage (Mardji, 1994). Data were analyzed descriptively and quantitatively and presented in tabular form to illustrate the severity of leaf spot disease in oil palm seedlings at the research location. The research also included a flowchart and activity schedule covering the proposal stage, survey, research implementation, data analysis, and results seminar.

3. Results and Discussion

3.1. Overview of Research Location

3.1.1. Geographical Location of Research Location

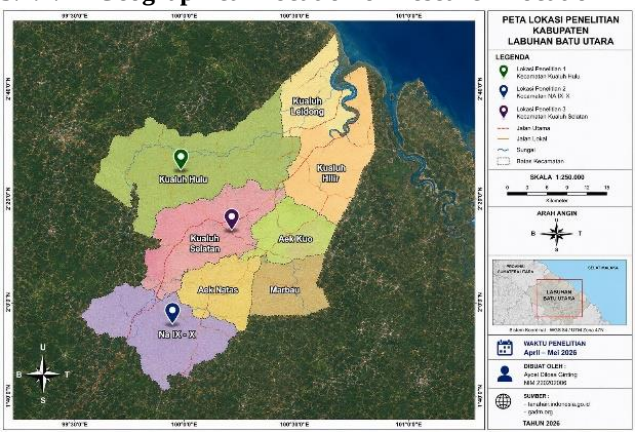

Figure 2. Location Study

North Labuhanbatu Regency is a regency in North Sumatra Province located at 1°58'–2°50' North Latitude and 99°25'–100°05' East Longitude with an area of approximately 3,545.80 km². This area includes the districts of Kualuh Hulu, Kualuh Selatan, and Na IX-X, which are the research locations. It borders Asahan Regency and the Malacca Strait to the north, Labuhanbatu Regency to the south and east, and South Tapanuli Regency and North Padang Lawas to the west. Topographically, this area is relatively flat to undulating with a tropical climate that supports the development of oil palm plantations, making it one of the centers of oil palm production in North Sumatra.

3.1.2. Oil Palm Nursery Conditions

The oil palm nurseries at the research sites, covering the Kualuh Hulu, Kualuh Selatan, and Na IX-X sub-districts, are generally managed by communities and plantation companies using a main nursery system. The nurseries aim to produce healthy, high-quality oil palm seedlings before transplanting them to the planting area, with management tailored to the conditions of each location.

Kualuh Hulu District has good nursery conditions, with relatively flat land that makes it easy to organize and maintain the seedlings. The seedlings are neatly arranged in polybags with good drainage to prevent waterlogging and keep the area clean and weed-free. Furthermore, optimal sunlight supports healthy growth of the oil palm seedlings in this location.

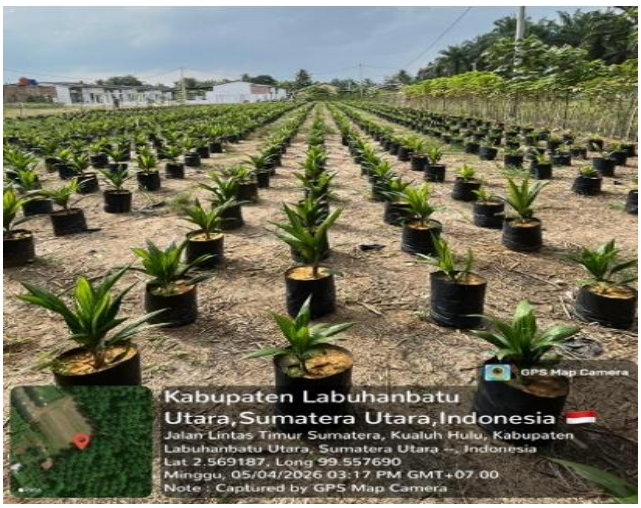

Figure 3. Land Conditions in Kualuh Hulu District

The oil palm nursery in Kualuh Selatan District is clean and well-maintained, with regular weed removal to support seedling growth. The slightly sloping land surface facilitates water flow and prevents flooding, while a good drainage system maintains optimal soil moisture.

Figure 4. Land Conditions in South Kualuh District

The overall condition of the oil palm nurseries in Na IX-X District remains quite good, supporting seedling growth, with the neat arrangement of polybags facilitating maintenance and monitoring. However, waterlogging is still present in several areas due to suboptimal drainage, as well as the presence of weeds in the form of grass and wild plants growing around the polybags. Nevertheless, soil fertility and moisture levels remain relatively good, supporting the growth of oil palm seedlings.

Figure 5. Land Conditions in Na IX X District

3.2. Results of Observations of Leaf Spot Disease in the Field

Observations of leaf spot disease in oil palm seedlings were conducted at three research locations: Kualuh Hulu, Kualuh Selatan, and Na IX-X, with a focus on the nursery area. Observations included disease symptoms, attack percentage, and disease intensity of leaf spot disease at each location to determine the severity and distribution of leaf spot disease in oil palm seedlings.

3.2.1. Symptoms of Leaf Spot Disease in Oil Palm Seedlings

Leaf spot disease is a common problem in oil palm nurseries. This disease generally attacks seedling leaves and is characterized by the appearance of brown, yellow, or blackish spots on the leaf surface. If the attack is severe enough, the leaves can dry out, become necrotic, and inhibit the growth of oil palm seedlings. Environmental conditions in the nursery, such as humidity, rainfall, land sanitation, and seedling spacing, influence the severity of leaf spot disease. Based on observations at several research locations, symptoms of leaf spot disease were found in oil palm nurseries in the Kualuh Hulu, Kualuh Selatan, and Na IX-X districts.

3.2.2. Symptoms of Leaf Spot Disease in Kualuh Hulu District

Observations showed that oil palm seedlings at the research site were experiencing mild to moderate leaf spot disease. Symptoms include small to large, blackish-brown spots scattered across several leaves in an irregular shape.

Figure 6. Symptoms of Leaf Spot Disease in Kualuh Hulu District

3.2.3. Symptoms of Leaf Spot Disease in Kualuh Selatan District

Based on observations in Kualuh Selatan District, oil palm seedlings exhibited mild to moderate leaf spot disease symptoms. Symptoms appeared on several leaves, appearing as round, oval, or elongated spots, dark brown to blackish in color. These spots initially appear small, then enlarge and spread across the leaf surface.

Some spots have a grayish-white or light brown center with a dark brown to black border and a yellowish halo. Some spots even merge, causing tissue damage or necrosis. Symptoms also include a yellowish-green leaf discoloration, which is more common on the lower leaves. In advanced stages, this can lead to drying and inhibit photosynthesis.

Figure 7. Symptoms of Leaf Spot Disease in Kualuh Selatan District

3.2.4. Symptoms of Leaf Spot Disease in NA IX-X District

Based on observations in Na IX-X District, oil palm seedlings exhibited moderate to severe leaf spot disease symptoms. Symptoms appeared on the leaf blades as small, round, oval, or elongated spots that initially appeared yellowish-brown, then progressed to dark brown to black and spread across the leaf surface.

Some spots have lighter centers with darker edges, and some even merge into areas of necrosis, damaging and drying of leaf tissue. Symptoms also include leaf discoloration from yellowish green to pale yellow, as well as drying of leaf tips and edges. Infection is more severe on older leaves and can inhibit photosynthesis and seedling growth.

Figure 8. Symptoms of Leaf Spot Disease in NA IX-X District

3.2.5. Percentage of Leaf Spot Disease Attacks

Observations on the percentage of leaf spot disease attacks on oil palm seedlings were conducted in three research locations, namely Kualuh Hulu, Kualuh Selatan, and Na IX-X. Observations were conducted twice with a one-month interval, namely the first observation in April 2026 and the second observation in May 2026. The results of these observations are presented in the Table 1.

Based on Table 1, the percentage of leaf spot disease attacks in oil palm nurseries increased at all research locations from the first observation to the second observation. In Kualuh Hulu District, of the 285 plants observed, the number of infected plants increased from 55 plants (19.30%) in the first observation to 75 plants (26.31%) in the second observation. In Kualuh Selatan District, of the 300 plants observed, the number of infected plants increased from 52 (17.33%) to 71 (23.66%). In NA IX-X District, of the 345 plants observed, the number of infected plants increased from 102 (29.57%) to 124 (35.94%).

These differences in disease severity likely reflect environmental conditions, humidity, nursery sanitation, and seedling maintenance techniques. Higher disease incidence reduces the growth and quality of oil palm seedlings in the nursery.

Based on the results above, the incidence of leaf spot disease in oil palm nurseries differed across the study locations. In the first observation, the highest incidence was in NA IX-X District (29.57%), while the lowest was in Kualuh Selatan District (17.33%). In the second observation, the percentage of disease incidence increased across all locations, with the highest value remaining in NA IX-X District (35.94%) and the lowest in Kualuh Selatan District (23.66%).

3.2.6. Intensity of Leaf Spot Disease Attack

The intensity of leaf spot disease attacks on oil palm seedlings was observed to determine the severity of the disease at each research location. Observations were conducted twice with a one-month interval: the first observation in April 2026 and the second observation in May 2026. Assessment of attack intensity was based on the severity of symptoms appearing on the leaves of the oil palm seedlings. Table 4.2 presents the results of observations of leaf spot disease attack intensity at the three research locations are presented in Table 2.

Based on Table 2, the results show that the intensity of leaf spot disease attack increased at all observation locations from the first to the second observation. In Kualuh Hulu District, the attack intensity increased from 8.21% to 11.15%, while in Kualuh Selatan District, it increased from 7.46% to 10.60%. Meanwhile, in IX-X District had the highest attack intensity, increasing from 13.68% in the first observation to 16.46% in the second observation. To clarify the comparison of leaf spot disease attack intensity at each location and observation time, the data are presented in graphical form in Figure 9.

Table 1. Percentage of Leaf Spot Disease Attacks

Subdistrict	Number of Plants Observed	Observation 1		Observation 2	
		Plant Attacked	Percentage Attack%	Plant Attacked	Percentage Attack%
Upper Kualuh	285	55	19.30	75	26.31
South Kualuh	300	52	17.33	71	23.66
NA IX-X	345	102	29.57	124	35.94

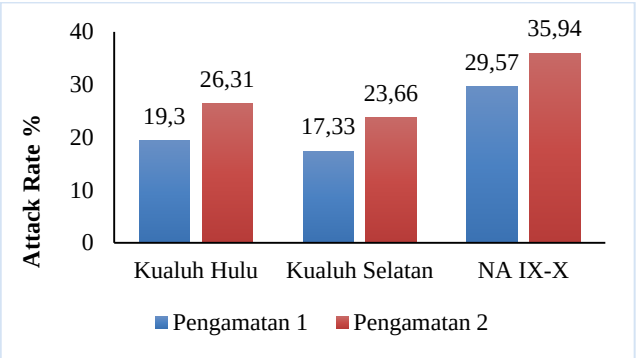

Figure 9. Percentage of Leaf Spot Disease Attacks on Oil Palm Seedlings

Table 2. Comparison of Leaf Spot Disease Intensity in Three Districts

Subdistrict	Observation 1	Observation 2
Upper Kualuh	8.21	11.15
South Kualuh	7.46	10.6
NA IX-X	13.68	16.46

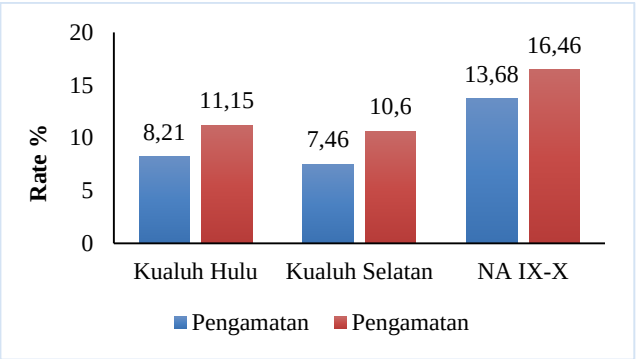

Figure 10. Comparison of Leaf Spot Disease Intensity

The intensity of leaf spot disease in oil palm nurseries showed differences in each study location and increased in the second observation. In the first observation, in IX-X District had the highest disease intensity at 13.68%, followed by Kualuh Hulu District at 8.21% and Kualuh Selatan District at 7.46%. Meanwhile, in the second observation, disease intensity increased to 16.46% in NA IX-X District, 11.15% in Kualuh Hulu District, and 10.60% in Kualuh Selatan District.

3.3. Results of Identification of Pathogens Causing Leaf Spot Disease

Based on the identification results, several fungal genera were obtained that were associated with leaf spot disease in oil palm seedlings, namely *Alternaria* sp., *Curvularia* sp., and *Aureobasidium* sp. The genus *Curvularia* sp. was found in more than one research location, namely Kualuh Hulu, Kualuh Selatan, and Na IX-X, so it is suspected to be one of the dominant fungi. In addition, other genera were also found with different morphological characteristics based on macroscopic and microscopic observations.

3.3.1. *Alternaria sp.* fungus

Based on macroscopic and microscopic observations, the isolates exhibit characteristics consistent with the genus *Alternaria*. Macroscopically, the colonies are spherical with radial growth, velvety to downy texture, and greenish-gray to blackish-brown in color with a darker center due to conidia formation. Microscopically, the isolates have septate hyphae, simple or branched pale brown conidiophores, and produce *catenulate conidia*.

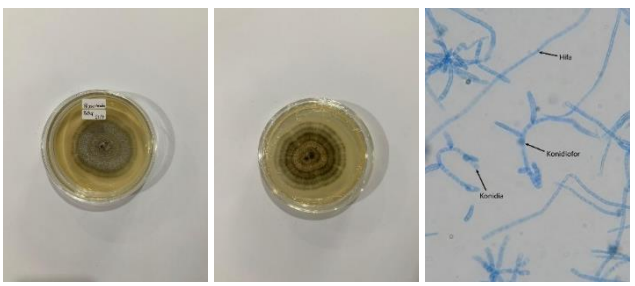

Figure 11. Macroscopic and microscopic characteristics of Alternaria

Conidia are brown, club-shaped (*clavate*) to obclavate,

have transverse and longitudinal septa (*muriform*), and are generally equipped with a beak. These characteristics are consistent with the description of the genus *Alternaria* proposed by Barnett and Hunter (1998) and Watanabe (2002). Alternaria sp. has septate mycelium with colonies that are generally gray-brown to olive green. Conidia are oval to obclavate, brown in color, and have transverse and longitudinal septa. A. alternata is reported to have conidia measuring approximately 38.02 × 7.12 µm, with 2–4 transverse septa and 0–2 longitudinal septa.(Rani et al., 2019).

3.3.2. Culvularia sp. fungus

Morphological identification results indicate that *Curvularia* sp. has gray to blackish-brown colonies. Microscopic observation reveals brown conidiophores that are generally simple or slightly branched. This fungus produces brown, curved conidia, composed of 3–4 partitions (4–5 cells). The central cell is larger and darker than the other cells, giving the conidia a distinctive curved shape. These characteristics are consistent with the description (Barnett & Hunter, 1998). This explains that *Curvularia* is a *dematiaceous fungus* that has pigmented conidia with enlarged central cells as the main characteristic in the identification process. Curvularia sp. has septate and branched hyphae with brown conidiophores. The conidia are curved to boat-shaped, brown in color, generally have 3 partitions, with the central cell larger and darker than the other cells. Curvularia conidia are reported to measure approximately 17.36–22.26 × 8.90–11.80 µm (Shivakumar & Patil, 2023). Based on the identification results in this study, *Curvularia* sp. was found in all research locations, namely Kualuh Hulu, Kualuh Selatan, and NA IX-X Districts, thus indicating that this fungus is a widespread pathogen and is associated with leaf spot disease in oil palm nurseries in North Labuhanbatu Regency.

Figure 12. Macroscopic and microscopic characteristics of the fungus *Curvularia sp.*

3.3.3. Aureobasidium sp fungus

Based on macroscopic observations, the isolate showed a compact colony with a dark brown to black center, while the edges were pink to brownish. The colony appeared flat (resupinate) with a yeast-like texture *and* darkened as it grew. These characteristics match the description of Aureobasidium (Watanabe, 2002). Aureobasidium sp. is a polymorphic fungus that can grow in the form of yeast-like cells or septate hyphae. The hyphae of Aureobasidium pullulans measure approximately 2–9 µm, while the conidia are elliptical, non-septate, and measure approximately 5.5–18 × 3–6 µm (Gaur et al., 2010). Microscopic observations also showed characteristics that support the isolate as belonging to the genus *Aureobasidium*. Septate hyaline hyphae with round to oval conidia were observed that formed directly on the sides of the hyphae without clearly developed conidiophores.

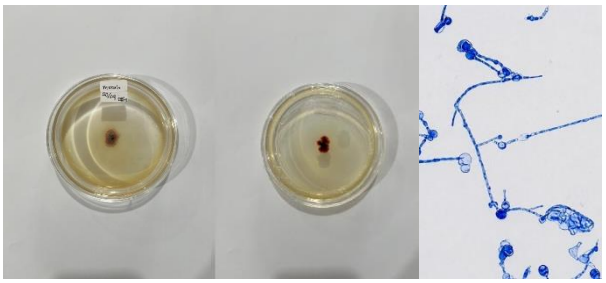

Figure 13. Macroscopic and microscopic characteristics of the fungus *Aureobasidium sp.*

Conidia appear to gather in masses along the hyphae, indicating a blastospore type of conidia formation. According to (Watanabe, 2002), the genus *Aureobasidium* is characterized by the absence or very underdevelopment of conidiophores (*conidiophores lacking*), while conidia are formed blastosporeally directly on the hyphae, both laterally and terminally, and often gather in masses of conidia on the hyphae.

4. Conclusion

Based on the research results, leaf spot disease was found, and the pathogen causing leaf spot disease was identified based on macroscopic and microscopic morphological characteristics as *Curvularia* sp. This fungus was found in all research locations, namely Kualuh Hulu District, Kualuh Selatan District, and NA IX-X District, so that *Curvularia sp. was determined as the pathogen causing leaf spot disease in* the main oil palm nursery at the research location. Symptoms include chocolate-to-blackish spots, which can cause necrosis and drying of leaf tissue. The percentage of leaf spot disease attacks varied across research locations and increased from the first to the second observation. In Kualuh Hulu District, the percentage of attacks increased from 19.30% to 26.31%. In Kualuh Selatan District, it increased from 17.33% to 23.66%. Meanwhile, NA IX-X District had the highest percentage of attacks, increasing from 29.57% to 35.94%.

References

Andersen, F. V., Himawan, A., & Kristalisasi, E. N. (2024). Kajian perkembangan penyakit pada bibit kelapa sawit di pre nursery

dan main nursery di PT. Inti Indosawit Subur (Asian Agri Group) Kebun Tungkal Ulu, Kec. Merlung, Kab. Tanjung Jabung Barat, Provinsi Jambi. *Agroforetech, 2*(1), 79–89.

Barnett, H. L., & Hunter, B. B. (1998a). *Illustrated genera of imperfect fungi* (4th ed.). APS Press.

Barnett, H. L., & Hunter, B. B. (1998b). *Illustrated genera of imperfect fungi*.

Badan Pusat Statistik. (2023). *Badan Pusat Statistik: BPS-Statistics Indonesia*.

Cameron, R. R., Yusticia, S. R., Afriani, S. R., & Febrianni, A. (2025). Analisis ambang batas intensitas serangan bercak daun yang disebabkan oleh *Curvularia* spp. pada bibit kelapa sawit. *Agrisaintifika: Jurnal Ilmu-Ilmu Pertanian, 9*(3), 654–662. https://doi.org/10.32585/ags.v9i3.6657

Defitri, Y. (2021). Intensitas dan persentase serangan beberapa penyakit utama pada tanaman sawit (*Elaeis guineensis* Jacq.) di Desa Tebing Tinggi Kecamatan Mara Sebo Ulu Kabupaten Batanghari. *Jurnal Ilmiah Universitas Batanghari Jambi, 21*(3), 1399. https://doi.org/10.33087/jiubj.v21i3.1761

Gaur, R., Singh, R., Gupta, M., & Gaur, M. K. (2010). *Aureobasidium pullulans*, an economically important polymorphic yeast with special reference to pullulan. *African Journal of Biotechnology, 9*(47), 7989–7997. http://www.academicjournals.org/AJB

Hutagalung, P. P., & Noer, Z. (2025). Eksplorasi patogen dan intensitas penyakit bercak daun pada bibit kelapa sawit Simalungun. *Jurnal Ilmiah Pertanian (JIPERTA), 7*(2), 194–203. https://doi.org/10.31289/jiperta.v7i2.6003

Manik, F. Y., Herdiyeni, Y., & Herliyana, E. N. (2016). Leaf morphological feature extraction of digital image *Anthocephalus cadamba*. *TELKOMNIKA, 14*(2), 1693–6930. https://doi.org/10.12928/TELKOMNIKA.v14i1.2675

Rani, N., Lal, H. C., & Kumar, P. (2019). Survey and morphological characterization of *Alternaria* spp. causing Alternaria blight of pigeon pea. *International Journal of Current Microbiology and Applied Sciences, 9*. http://www.ijcmas.com

Shivakumar, & Patil, M. B. (2023). Morphological variability of the *Curvularia lunata* associated with grain discoloration of rice. *International Journal of Plant & Soil Science, 35*(21), 921–928. https://doi.org/10.9734/ijpss/2023/v35i214062

Suharti, N., Habazar, T., Nasril, N., Dachryabus, & Jamsari. (2011). *Induksi ketahanan tanaman jahe terhadap penyakit layu Ralstonia splanacearum ras 4 menggunakan mikoriza arbuskular (FMA) indigenus*.

Walida, H., Harahap, F. S., & Siregar, D. A. (2024). The effectiveness of the inhibition of local bacterial isolate from the rhizosphere of oil palm plant on leaf spot disease in purple eggplant (*Solanum melongena* L.). *Jurnal Agronomi Tanaman Tropika (JUATIKA), 6*(1), 11–18. https://doi.org/10.36378/juatika.v6i1.3403

Watanabe, T. (2002). *Soil and seed fungi: Morphologies of cultured fungi and key to species* (2nd ed.). CRC Press.

Wibowo, C. S., Apriyanto, A., Ernawan, R., Neing, D., Susilo, R., Cordell, H. J., Gatehouse, A. M. R., & Edwards, M. G. (2023). Genetic variants associated with leaf spot disease resistance in oil palm (*Elaeis guineensis*): A genome-wide association study. *Plant Pathology, 72*(9), 1626–1636. https://doi.org/10.1111/ppa.13774