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RESEARCH ARTICLE Open Access

Identification of The Causes of Base Rot Disease of Palm Oil In Two Villages In Kampar And Siak Districts of Riau Province

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Abstract

Palm oil (*Elaeis guineensis* Jacq.) is an important plantation crop in Indonesia including in Riau Province. Palm oil productivity in Riau has decreased due to several factors, one of which is disease. An important disease in palm oil plantations is stem base rot (BPB) caused by the fungus *Ganoderma sp*. This study aims to identify the causes of BPB disease of palm oil in Deli Makmur Village, Kampar Regency and Jati Baru Village, Siak Regency. This research was conducted using survey and observation methods in palm oil plantations in two villages in Kampar and Siak Districts. The identification of pathogens was carried out based on morphological characteristics by making macroscopic and microscopic observations. Initial diagnosis based on symptoms and signs palm oil plants found in Deli Makmur Village and in Jati Baru Village showed symptoms of stem base rot (BPB). The results of morphological identification show that the pathogen causing BPB disease is *Ganoderma sp*. The macroscopic and microscopic characteristics of the two *Ganoderma sp*. fungal isolates are slightly different, where the fungal isolate from Deli Makmur Village mycelium grows sideways, has a smooth and very thick texture, there are concentric rings, crystals and cuticular cells. While the mushroom isolate from Jati Baru Village mycelium grows sideways, has a fine texture, is quite thick, and there are no ring-shaped concentric, crystals and cuticular cells.

Keywords: Base Rot Disease, *Ganoderma sp*., Identification,Palm Oil, Riau

1. Introduction

An important plantation crop in Indonesia is palm oil (*Elaeis guineensis* Jacq.). Palm oil and palm kernel oil produced by palms oil are mainly used by the food and non-food industries. Palm oil is used as a raw material in the food industry to make margarine, cooking oil, specialty fats, and certain types of cakes. Through a hydrolysis process, palm oil is used by the non-food industry to make soap, detergents, diesel fuel, and cosmetics (Sunarko, 2007). These advantages make palm oil a valuable and important commodity for people's income sources and sustaining human life. Therefore, palm oil is widely planted throughout Indonesia, including in Riau Province.

The largest palm oil plantation in Idonesia is in Riau Province which in 2021 has a land area of 2.71 million ha with a production of 7.84 million tons and a productivity of 2.89 $t.ha^{-1}$. In 2022 the land area shrank to 1.73 million ha and there was a decrease in production to 4.09 million tons with a productivity of 2.36 $t.ha^{-1}$. Large palm oil plantations in Riau province are located in Kampar Regency and Siak Regency. The area of smallholder palm oil plantations in Kampar Regency and Siak Regency is 279 thousand ha and 208 thousand ha respectively (Direktorat Jenderal Perkebunan, 2022). Disease, poor soil quality, unfavorable environmental conditions, and poor agricultural practices are the main causes of declining palm oil productivity in Riau.

Stem rot disease is a disease that threatens the production of palm oil plants, because it can cause a decrease in productivity and death of the plant. This disease is caused by the fungus *Ganoderma sp*. which is a soil-borne pathogen. Ganoderma attacks the roots and trunk of palm trees, both old and young plants, then causes frost at the base of the trunk. Ganoderma disease infection spreads through spores and root contact. According to Yosephine et al. (2024), one type of disease What usually attacks oil

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palm plants is stem rot disease or commonly known by the abbreviation BPB.

Until now, experts agree that BPB disease is caused by the genus Ganoderma, but until now there are still differences of opinion regarding the species of the fungus concerned (Semangun, 2008). Important pathogens that often attack palm oilplants are Ganoderma which causes stem rot diseas (Andriani et al., 2022). Ganoderma will make oil palm trees will have a very large number of spear leaves, damaged leaf midribs hanging on the oil palm trunk, fruiting bodies near the base of the trunk, and rotting adventitious roots (Castillo et al., 2022).

According to (Khoo & Chong, 2023), palm oil plantations can suffer considerable economic losses of up to 43% if BPB disease is not stopped within six months. (Dahang et al., 2021) stated that in addition to causing direct financial losses, BPB can result in a shorter than normal productive life of palm oil plants.

Tree crowns can be used to identify signs of BPB disease in palms oil caused by *Ganoderma sp*. Leaves that do not open completely are more common in diseased trees. Leaves are light green and pale, older leaves will wilt, break at the midrib, and dangle around the trunk (Semangun, 2008). *Ganoderma sp*. can attack palms oil during the nursery stage and during the production stage. The disease appears on the leaves of sprouts and seedlings when *Ganoderma sp*. fruiting bodies first appear at the base of the stem. This is followed by necrosis (tissue death) of the leaf veins as the seedlings die due to lack of nutrients (Alviodinasyari et al., 2015).

Symptoms of BPB on palms oil were found in Deli Makmur Village, Kampa District, Kampar Regency, and in Jati Baru Village, Bungaraya District, Siak Regency. Based on these problems, it is necessary to conduct research to identify morphologically macroscopic and microscopic pathogens that cause BPB on oil palm plants in Deli Makmur Village, Kampa District, Kampar District and in Jati Baru Village, Bungaraya District, Siak District.

2. Material and Methods

This research was conducted at the Plant Disease Laboratory of the Faculty of Agriculture, University of Riau, Bina Widya Campus, Km 12.5, Simpang Baru Village, Tampan District, Pekanbaru coordinates location 101° east longitude and 0,48° north latitude, oil palm plantations in Deli Makmur Village, Kampa District, Kampar Regency (101° east longitude, and 0,5° north latitude) at Figure 1. and in Jati Baru Village, Bungaraya District, Siak Regency 102° east longitude and 0° north latitude) at Figure 2. and the Class 1 Pekanbaru Quarantine Center Laboratory.

Figure 1. Location of sampling area for mushroom fruiting bodies in Deli Makmur Village

Figure 2. Location of sampling area for mushroom fruiting bodies in Jati Baru Village

Sampling locations were carried out on farmers' land in two villages, namely Deli Makmur Village, Kampa District, Kampar Regency and Jati Baru Village, Bungaraya District, Siak Regency, Riau Province. The sampling technique used purposive sampling, namely taking plants that show symptoms of disease. Samples were taken as many as 5 points diagonally (Figure. 3). Each point is taken one sample of the fruiting body of the fungus suspected *Ganoderma sp*. on plants with symptoms of oil palm BPB disease. Samples of fungal fruiting bodies that have been taken are then placed in plastic containers and taken to the laboratory for isolation.

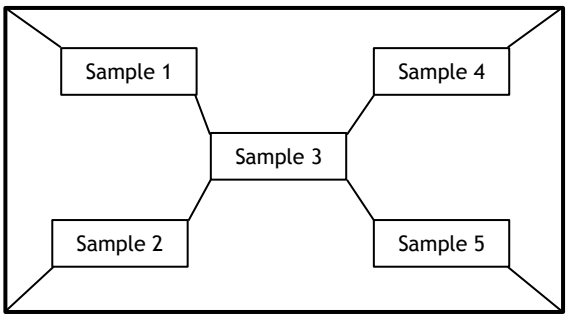

Figure 3. Sampling design of oil palm

The research flow diagram can be seen in Figure 4. The method of tissue cultivation on PDA media is used to isolate the fungus that causes BPB disease in oil palm plants (Kusdiana et al., 2021). The fruiting body of the fungus is cut with a size of 1x1 cm. The mushroom fruiting body pieces were immersed in a 10% NaOCl2 solution for 3 minutes, then immersed in sterile distilled water for 3 minutes and repeated 2 times. After that, it was dried on sterile tissue paper. The pieces of mushroom fruiting bodies were placed and arranged on sterile PDA media, in petri dishes of 4 pieces of mushroom fruiting bodies per petri dish and incubated for 7 days in an incubator.

Purification is done if the fungus isolated on PDA has grown. Fungi that grow on PDA media are cut at the edge of the colony using a 5 mm diameter cork borer, then transferred to other PDA media in a petri dish to grow. All fungal isolates that have been transferred to PDA media in other petri dishes are multiplied until they get homogeneous isolates. Isolates suspected to be *Ganoderma sp*. with the characteristics of white mycelium, the direction of mycelium growth spreads laterally and the texture of the mycelium is smooth will be propagated for identification.

Fungal identification is done morphologically which includes macroscopic and microscopic characteristics. Macroscopic characteristics are done visually by observing the color of the mycelium, the direction of mycelium growth (upward or sideways) and the texture of the mycelium (rough or smooth). The tools and materials used were *Ganoderma sp*. isolate, microscope, object glass and cover glass.Microscopic observations were made with the wet preparate method by dripping with distilled water, then covered with a glass cover and observed hyphae, conidia and conidiophores with a binocular microscope magnification of 10x40. Macroscopic identification of fungi is guided by the results of research by (Hamzah et al., 2021) and microscopically (Bdalyan et al., 2019).

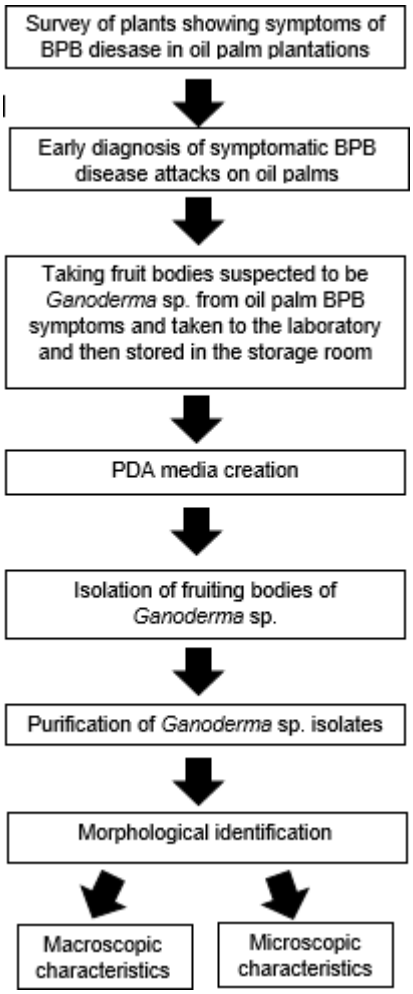

Figure 4. Research flow diagram

3. Results and Discussion

3.1. Early Diagnosis of Blight Base of Trunk (BPB)

The results of disease symptom diagnosis on palm oil plants located in Deli Makmur Village, Kampa District, Kampar Regency and those in Jati Baru Village, Bungaraya District, Siak Regency can be seen in Figure 5.

Figure 5 shows that palm oil plants in Deli Makmur Village and Jati Baru Village have similar symptoms in the form of more spear leaves than usual, broken fronds dangling and hanging around the trunk of the plant, the presence of fruiting bodies around the base of the plant stem, and adventitious roots that rot and rot. These are symptoms of BPB infected plants. The attack category of *Ganoderma sp*. on these oil palm plants is heavy.

According to (Castillo et al., 2022), oil palm trees attacked by *Ganoderma sp*. have a large number of spear leaves than usual, broken fronds and hanging around the trunk, the presence of fungal fruiting bodies at the base of the plant stem and rotting adventitious roots.

Figure 5. Oil palm plants with BPB disease symptoms (A: Symptomatic plants in Deli Makmur Village, B: Symptomatic plants in Jati Baru Village (x: broken fronds hanging around the stem)

Early symptoms of BPB disease in oil palm trees are yellowish and dull leaves that are not shiny (pale), there is an association on the spear leaves. Young leaves that do not open completely, leaf midribs dry out. Plants that are severely affected are characterized by the presence of fungal fruiting bodies around the base of the plant stem and over time the plant will fall (Salsabila et al., 2022). According to (Hutagaol et al., 2024), if BPB disease attacks young plants, the leaves will be increasingly stunted, as the disease progresses, the spear leaves and leaves turn yellow, dry, and break. In addition, the plant will collapse due to decay at the base of the stem during the late stages of symptoms, causing the plant to die and rot. According to (Maharany et al., 2024), the classification of Ganoderma attack is a mild attack that can be seen in pale yellowish green leaves and no shine. Moderate attacks cause upright trees with yellowing leaves, spear leaves do not open completely. Severe attacks are the presence of fungal fruiting bodies at the base of the trunk, decay occurs at the base of the trunk, the tree tilts and almost falls.

3.2. Morphological Identification of Fungi Causing BPB Disease

The results of morphological identification carried out from isolates of fungal fruiting body isolates are known to be *Ganoderma sp*. Morphological identification of fungi that cause BPB disease is carried out by observing macroscopically and microscopically. The results of the identification of pathogens that cause BPB in oil palm plants from Kampar Regency can be seen in Table 1, Figure 6 and Figure 7.

Macroscopic characteristics include colony color, direction of spread and mycelium shape. Microscopic characteristics include conidia shape, hyphae shape, basidiospore size and conidia size. Macroscopic characteristics of *Ganoderma sp*. obtained are white / creamy white, round shape, direction of spread to the side, smooth and thick textured mycelium.

Microscopic characteristics include conidia shape, hyphae shape, basidiospore size and conidia size. This is in line with the research of (Susanto et al., 2013) that the colonies of *Ganoderma sp*. are yellowish white like velvet and smooth in texture. Mycelium growth of these fungi tends to be slow. Mycelium grew to fill a 9 cm diameter petri dish on the 10-12th HSI.

This is in line with the research of (Rakib et al., 2014) that the colonies of *Ganoderma sp*. are yellowish white to brownish, smooth textured and concentric. Mycelium growth tends to be slow, 10-12 days of new mycelium can grow to fill a 9 cm diameter petri dish.

Microscopic characteristics show that *Ganoderma sp*. has concentrated hyphae, clamp connections, bubbly hyphae, cuticular cells and crystals. Figure 6(A) shows the shape of the clamp connection when the hyphae cells have undergone cell division and formed new hyphae, while Figure 6(B) shows the shape of the clamp connection when the hyphae cells have undergone cell division. Figure 6(B) is the shape of the clamp connection when the hyphae cells have not undergone cell division. (Furtado, 1966) states that clamp connections are formed when cell division has occurred and formed new cells. (Money, 2016) explains that hyphae that have not undergone cell division can form rudimentary clamp connections.

The results of the identification of pathogens causing BPB disease in oil palm plants originating from Siak District can be seen in Table 2, Figure 8 and Figure 9. The observation of macroscopic and microscopic characteristics of the fungus that causes BPB disease of oil palm from Jati Baru Village was carried out on the 10th day and 14th day of HSI. The results of observations of the macroscopic characteristics of *Ganoderma sp*. obtained are white / creamy white, round in shape, the direction of mycelium growth spreads sideways, smooth and thick textured.

Table 1. Identification of pathogens causing BPB disease in Palm Oil plants origin of Deli Makmur Village

Morphological Characteristics	Research Results	Previous Research Results
Macroscopic:		Hamzah *et al*., 2021
Colony Color	White/yellowish white	White/yellowish to brownish white
Direction of Spread	Growing sideways	Growing sideways
Mycelium Shape	It grows wavy, fine-textured and thick	Smooth, thick, slightly bumpy texture and solid
Concentric Colonies	There are concentric shaped colonies circle ring	There are concentric ring-shaped colonies.
Microscopic:		Badalyan *et al*., 2019
Crystal form	Hexagon-shaped crystal	Crystalline
Conidia Shape	Oval	-
Hyphal Shape	Hyphae are adhesive, have *clamp connector*, bubbly hyphae, there are cuticular cells	There are clamp ties (*clamp connector)*, bubbly hyphae, there are cuticular cells
Basidiospore size	7.10 x 3.88µm	-
Conidia size	2.42 x 1.53 µm	-

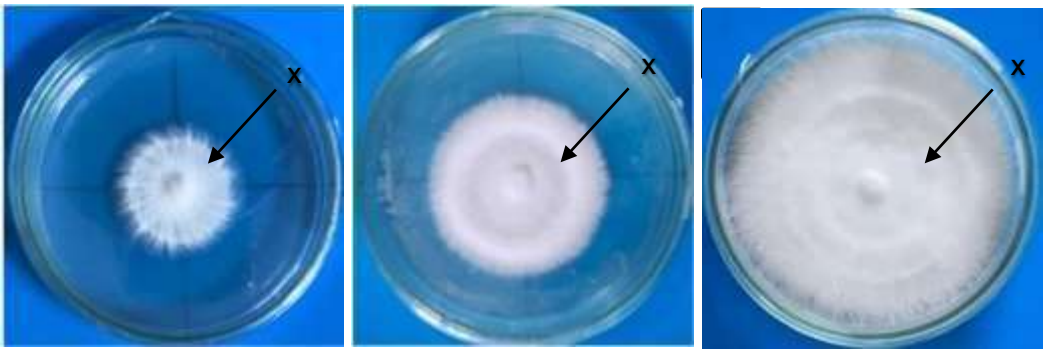

Figure 6. Macroscopic characteristics of fungal isolates from Deli Makmur Village, A: 5 HSI, B: 7 HSI, C: 10 HSI (x: mycelium)

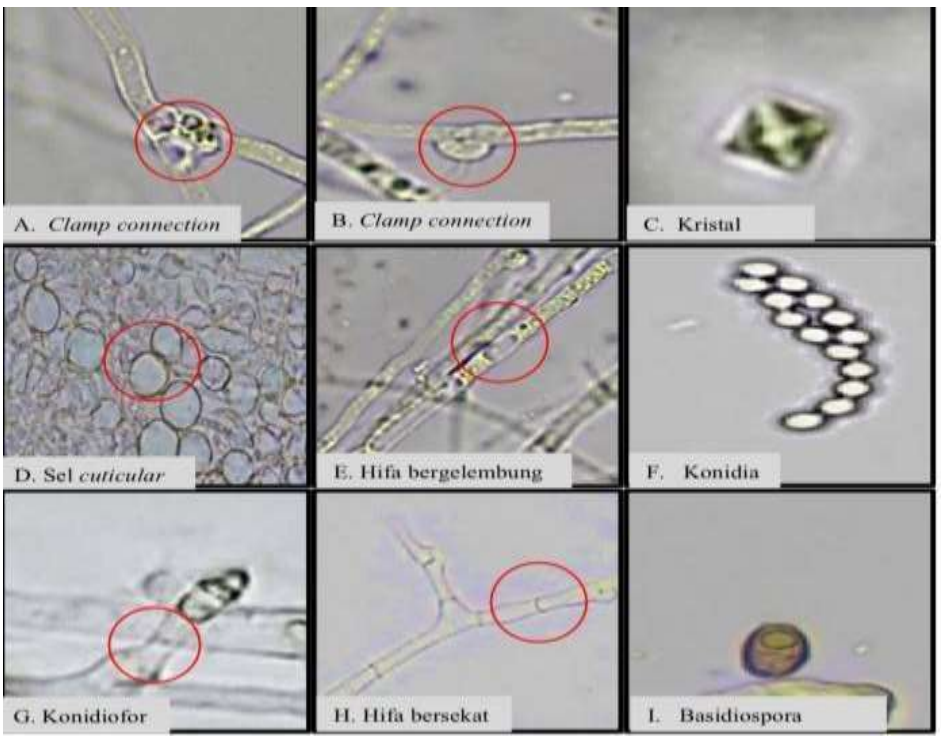

Figure 7. Microscopic characteristics of fungal isolates from Deli Makmur Village cause BPB with a 10x40 magnification microscope

This is in accordance with the research of (Susanto et al., 2013) that the colonies of *Ganoderma sp*. are yellowish white like velvet. Mycelium growth of these fungi tends to be slow. The mycelium grew to fill a Petri dish with a diameter of 9 cm on the 10th-12th day. The macroscopic characteristics of *Ganoderma sp*. colonies can be seen in Figure 8.

Microscopic characteristics of *Ganoderma sp*. can be seen in Figure 9. Microscopic characteristics show that *Ganoderma sp*. has hyphae that are fused, bubbly hyphae, has conidiophores, has conidia that are oval in shape and there is a clamp connector. According to the results of research by (Yu & Chong, 2018) *Ganoderma sp*. mushrooms have clamp connectors that describe the characteristics of fungi in the phylum Basidiomycota.

Table 2. Identification of pathogens causing BPB disease in Oil Palm plants Jati Baru Village origin

Morphological Characteristics	Research results	Previous Research Results
Macroscopic:		Hamzah *et al.*, 2021
Colony Color	White/yellowish-white	White/yellowish-white
Direction of Spread	Growing sideways	Growing sideways
Mycelium Shape	Smooth and thick textured	Fine-textured, thick, slightly dense
Microscopic:		Badalyan *et al*., 2019
Conidia Shape	Oval	-
Hyphal Shape	Hyphae are adhesive, have *clamp connectors*, hyphae are bubbly	There are clamp ties (*clamp connector)*, bubbly hyphae, there are *cuticular* cells
Basidiospore size	6.18 x 3.77 µm	-
Conidia Size	2.76 x 1.82 µm	-

The macroscopic and microscopic characteristics of the two isolates of *Ganoderma sp*. taken from oil palm plants in Deli Makmur Village and Jati Baru Village have some differences. *Ganoderma sp*. fungus isolates from Deli Makmur Village have macroscopic characteristics, namely mycelium growth that grows wavy, thicker, spreads laterally and the presence of concentric ring-shaped colonies. Whereas the *Ganoderma sp*. mushroom isolate from Jati Baru Village has macroscopic characteristics, namely the mycelium grows sideways and has a thick smooth texture. This is in accordance with the research of (Hamzah et al., 2021) that the mycelium growth of *Ganoderma sp*. fungi grows sideways, has a smooth, thick and dense texture.

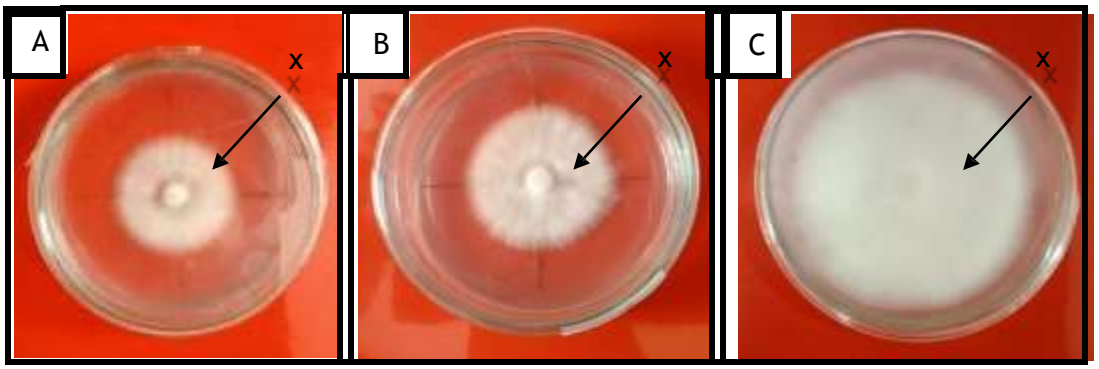

Figure 8. Macroscopic characteristics of fungal isolates from Jati Baru Village., A: 5 HSI, B: 7 HSI, C: 10 HSI (x: mycelium)

BPB disease is caused by fungi of the genus Ganoderma such as *G. boninense* Pat., *G. tropicum*, *G. philipii*, *G. chalceum*, *G. colossus*, *G. fornicatum*, *G. steyaertanum*, *G. lucidum* Karst., *G. cochlear*, *G. laccatum* Kalchbr., *G. miniatocinctum*, *G. pediforme* and *G. tornatum* (Semangun, 2000). Susanto et al. (2013) explained that the fungal isolate *G. boninense* has a yellowish white mycelium like velvet and grows spread laterally. The mycelium grew to fill a Petri dish with a diameter of 9 cm on days 10-12, it was due to the slow growth of the mycelium. (Aditya et al., 2024) explained that the fungal isolate *G. steyaertanum* on PDA media showed white mycelium at the beginning of its growth. Mycelium structure is straight, smooth, not clumped and concentric. (Puspitasari & Rimbawanto, 2010) explained that isolates of the fungus *G. philipii*, namely the initial mycelium, looked like fibers that were pure white. The mycelium is fine-textured, thick and the growth is not neat at the edges.

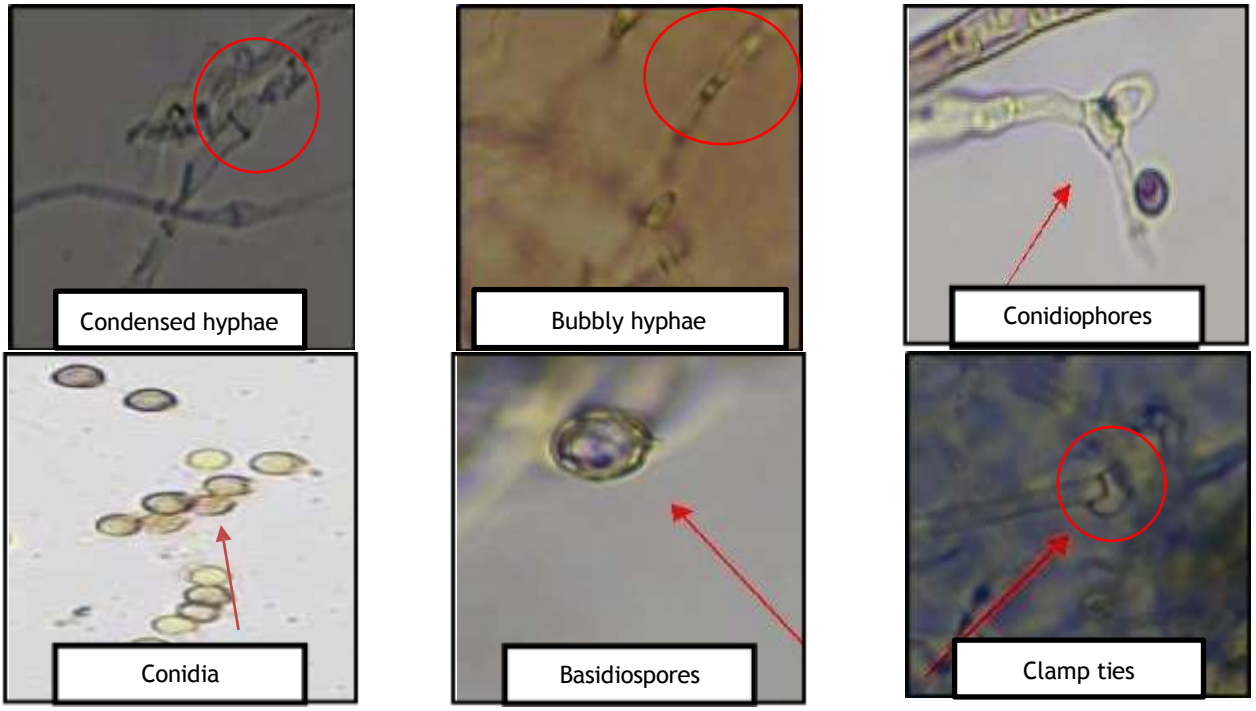

Figure 9. Microscopic characteristics of fungal isolates from Jati Baru Village causing BPB with 10x40 magnification microscope

Isolates of *Ganoderma sp*. from Deli Makmur Village have microscopic characteristics, namely the presence of crystals and cuticular cells, while isolates of *Ganoderma sp*. from Jati Baru Village do not have crystals and cuticular cells. The two isolates of *Ganoderma sp*. mushrooms both have clamp connections, bubbly hyphae, conidia, conidiophores, adhesive hyphae and basidiospores. The basidiospores of the two isolates of *Ganoderma sp*. are oval in shape. (Loyd et al., 2018) stated that *G. lucidum* has basidiospores that are broadly oval and golden brown in color. (Luangharn et al., 2020) in their research explained that *G. gibbosum* has oval basidiospores that are reddish brown in color. Septic hyphae are composed of generative hyphae and skeletal hyphae. (Badalyan et al., 2019) explained that *G. adspersum* has cuticular cells that are round brownish in color, hyphae are hyaline, there are pincer bonds and crystals. Crystal is one of the characteristics of the fungus *G. adspersum*.

4. Conclusion

Initial diagnosis based on symptoms and signs found in Deli Makmur Village and Jati Baru Village showed symptoms of stem base rot (BPB). Morphological identification results showed that the pathogen causing BPB disease was *Ganoderma sp*.

The macroscopic characteristics of the two *Ganoderma sp*. mushroom isolates are slightly different, where in the mushroom isolate from Deli Makmur Village the mycelium grows sideways, has a fine texture and is very thick and there are ring-shaped concentricities. Whereas in the mushroom isolate from Jati Baru Village the mycelium grows sideways, has a fine texture, is quite thick, and there are no ring-shaped concentricities. Isolates of *Ganoderma sp*. from Deli Makmur Village have microscopic characteristics, namely the presence of crystals and cuticular cells, while in isolates of *Ganoderma sp*. from Jati Baru Village there are no crystals and cuticular cells.

Based on the research conducted, it is known that there are many species of Ganoderma fungi that cause BPB disease. Therefore, it is necessary to carry out molecular identification to find out more specific species of *Ganoderma sp*. causing BPB disease in Deli Makmur Village and Jati Baru Village.

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