

Diversity of diseases of rice (*Oryza sativa*) in Kutai Kartanegara, Indonesia

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Abstract. *Sopialena, Sofian, Nurdiana J. 2019. Diversity of diseases of rice (Oryza sativa) in Kutai Kartanegara, Indonesia. Asian J Agric 3: xxxx.* This research aimed to identify the diversity of diseases which becoming the main threat to four paddy varieties in Kutai Kartanegara, Indonesia. Though similar studies have been spotted, however, to our knowledge, this research brings significant findings in related to the diverse categories of plant diseases in the specific geographical area. The study was performed in Sidomulyo village, Anggana district using a purposive sampling method. From the selected paddy fields in the size of 2x2 square meter, the samples then were identified. Further analysis was performed to every suspected infected part of the plants. The results showed that there are five dominated plant diseases found, i.e., Blast disease, brown spot, narrow brown spot, false smut, and Sheath blight whereas the main cause of the diseases recorded are fungus and bacteria, i.e., *Pyricularia grisea* (Cke) Sacc., *Cercospora oryzae* Miyake., *Rhizoctonia solani* Kuhn., *Helminthosporium oryzae* L., *Ustilaginoidae virens* (Cke), and *Xanthomonas campestris* pv. *oryzae* Dye.

Keywords: Diseases, rice

INTRODUCTION

Rice becomes one of the worlds' primary staple food and food security for many countries (Remans et al. 2014; Hafiz et al. 2015; Zhang et al. 2017; Chang et al. 2018), including for Indonesians (Widyanti et al. 2014). Nevertheless, there is still a shortage of rice production (Bantacut 2014). One of the main reasons for this issue is the reduced harvested area and the decrease in productivity, which mainly happened in Kutai Kartanegara and Berau regencies (Badan Pusat Statistik 2016). In 2015 the rice production reached 408.78 thousand tons of dry grain (GKG) or reduced by 17.78 thousand tons compared to 2014 (Badan Pusat Statistik 2016). Therefore, it is necessary to identify the possibility another potential land that can be expanded into crop-based agriculture land, e.g., tidal water rice fields (Mareza et al. 2016; Setyo and Elly 2018). Besides tidal fields, the agro-ecosystems can be identified as irrigated rice fields, rain-fed rice fields, deep water rice fields and upland rice fields (Jayanthi et al. 2006). In East Kalimantan alone, tidal areas can be found in many places, including at Sidomulyo Village, Anggana at about 700 ha. (Dinas pangan, tanaman pangan dan hortikultura 2017). From the existing land area, most of them have been used the paddy varieties such as *Ciherang*, *Cimelati* and *Mekongga* (Susilastuti 2018). Though the use of plant-based pesticides is becoming more common among the farmers (Sopialena et al. 2018b), the pathogenic microorganisms seem to be the potential problems still. In this regard, this study found that *Pandan Ungu* variety is rarely used due to its susceptible characteristics to pathogens.

The types of plant-disturbing organism in host plants may vary (Saunders et al. 2010; Suyadi et al. 2017; Sopialena et al. 2018). In East Kalimantan, the most common pathogens experienced are Blast (*Pyricularia grisea* (Cke) Sacc.), *Hawar daun bakteri* (*Xanthomonas campestris* pv. *oryzae* Dye.), *Bercak daun coklat* (*Helminthosporium oryzae* L.), and *tungro* (Sopialena and Pratiwi 2017). The disease can lead to crop failure and may attack both the vegetative and generative phases of the root, leaves, stems, or panicles of rice plants (Rodriguez et al. 2009; Gao et al. 2010; Ariyanto et al. 2013). The blast disease (*Pyricularia grisea* (Cke) Sacc.) may lead to death for rice nursing plants and the decrease of the quality of grain, which mainly caused by the *Helminthosporium oryzae* L, whereas *hawar pelepah* or *Upih* disease may cause the seeds failed to germinate (Kihoro et al. 2013; Sopialena and Pratiwi 2017). Also, there are other diseases caused by pathogens which are harmful to the plants, such as false smut disease and sheath blight (Sopialena and Pratiwi 2017). The needs to fulfill the rice production and the potential of tidal land, especially in the village of Sidomulyo, Kutai Kartanegara, became the central issue to take this research into account. Further, this identification provides a broader picture of how to combine the planting management (e.g., the use of paddy varieties) within the geographical characteristics (Stringer et al. 2016).

This study was intended to enrich the discussion on the type of diseases at different local paddy varieties for tidal fields, in particular in the area of East Kalimantan.

MATERIALS AND METHODS

This research has been conducted in tidal rice fields at Sidomulyo Village, Anggana, Kutai Kartanegara Regency. It has supported climatic conditions with the average of rainfall is 2051.50 mdpl, the temperature of 26.80 °C and relative humidity at about 60-80%. The tidal rice fields are known as the lands that experience the overflow of tidal water in a specified period. The research was conducted in the cropping areas of 1 ha crop, and divided the area into 50 m x 12 m. The information was collected using purposive sampling based on specific criteria, i.e., the identification of infected plants, both in vegetative and generative phases. Direct observation was performed to identify the symptoms of the diseases in four different local paddy varieties (i.e., *Pandan ungu*, *Cimelati*, *Mekongga*, *Cigeulis*). In the area of paddy tile (*ubinan*) with a size of 2x2 square meter, for each suspected parts of the plants (leaf and stem) which were infected, it will be cut to about 5-10 cm and analyzed in the laboratory.

To identify diseases caused by a fungus, the samples of the plants were cut into small pieces first and sterilized using aquadest before soaking in a 70% alcohol solution for about 15-20 seconds. The next step is to dry the sample over the tissue, before transferring it into a cup that has contained Potato Dextrose Agar (PDA) media using nippers, and let it for isolation about 2-3 days. An ose of the needle and a methylene blue liquid was used to examine the growth of the fungal colonies. On the other hand, the identification of disease suspected because the bacteria is made through bacterial isolation to see the colony's morphological features, colonic features, bacterial cell shape, and colony color (Saunders et al. 2010). The isolation of the bacteria taken from the infected plants was

conducted by preparing the media on petri cultivation for some time waiting it to be cool and stable.

How to isolate the one pathogen that attack in different stage, such as leaf blast disease attack in vegetative stage have a different methods for isolating their single spore to neck blast which attack in late stage, generative stage? This methods should be explained.

RESULTS AND DISCUSSION

The findings

The observations in the vegetative phase were performed when the plants were about 1-8 weeks, while the generative phase was conducted when the plants reached 9-14 weeks after planting. The information of the type of diseases at different paddy varieties in vegetative and generative phase was presented in Table 1.

Diseases in the vegetative phase

The results of the identification process to the paddy varieties of *Cimelati*, *Cigeulis*, *Pandan ungu*, and *Mekongga*, indicated that the types of main potential diseases in the vegetative phase could be classified into three types, i.e., *Hawar daun bakteri*, *Blast*, and *Bercak coklat*. As presented in Figure 1.A, *Hawar daun disease* is caused by the infection of *Xanthomonas campestris* pv. *oryzae* Dye. It begins with the appearance of gray (yellowish) spots on the leaf edge. In its development, the symptoms will expand, forming blight, and eventually cause the leaves to dry out. This disease also attacks *Cimelati*, *Cigeulis*, and *Mekongga* varieties.

Table 1. The identification of rice diseases in different paddy varieties

Variety	Growth phases	
	Vegetative	Generative
	1-8 weeks after plantation	9-14 weeks after plantation
<i>Cimelati</i>	<i>Hawar daun bakteri</i> (<i>Xanthomonas campestris</i> pv. <i>oryzae</i> Dye.) <i>Blast</i> (<i>Pyricularia grisea</i> (Cke) Sacc.) <i>Bercak coklat</i> (<i>Helminthosporium oryzae</i> L.)	<i>Hawar daun bakteri</i> (<i>Xanthomonas campestris</i> pv. <i>oryzae</i> Dye.) <i>Bercak coklat</i> (<i>Helminthosporium oryzae</i> L.) Blast (<i>Pyricularia grisea</i> (Cke) Sacc.) <i>Gosong palsu</i> (<i>Ustilaginoidae virens</i> (Cke) Tak.)
<i>Cigeulis</i>	<i>Hawar daun bakteri</i> (<i>Xanthomonas campestris</i> pv. <i>oryzae</i> Dye.) Blast (<i>Pyricularia grisea</i> (Cke) Sacc.)	<i>Hawar daun bakteri</i> (<i>Xanthomonas campestris</i> pv. <i>oryzae</i> Dye.) <i>Bercak coklat</i> (<i>Helminthosporium oryzae</i> L.) <i>Blast</i> (<i>Pyricularia grisea</i> (Cke) Sacc.) <i>Hawar pelepah or upih</i> (<i>Rhizoctonia solani</i> Khun.) <i>Bercak daun sempit</i> (<i>Cercospora oryzae</i> Miyake.)
<i>Pandan ungu</i>	<i>Bercak coklat</i> (<i>Helminthosporium oryzae</i> L.) <i>Blast</i> (<i>Pyricularia grisea</i> (Cke) Sacc.)	<i>Hawar daun bakteri</i> (<i>Xanthomonas campestris</i> pv. <i>oryzae</i> Dye.) <i>Bercak coklat</i> (<i>Helminthosporium oryzae</i> L.) <i>Blast</i> (<i>Pyricularia grisea</i> (Cke) Sacc.) <i>Hawar pelepah/ upih</i> (<i>Rhizoctonia solani</i> Khun.)
<i>Mekongga</i>	<i>Hawar daun bakteri</i> (<i>Xanthomonas campestris</i> pv. <i>oryzae</i> Dye.) <i>Bercak coklat</i> (<i>Helminthosporium oryzae</i> L.) <i>Blast</i> (<i>Pyricularia grisea</i> (Cke) Sacc.)	<i>Hawar daun bakteri</i> (<i>Xanthomonas campestris</i> pv. <i>oryzae</i> Dye.) <i>Bercak coklat</i> (<i>Helminthosporium oryzae</i> L.) <i>Blast</i> (<i>Pyricularia grisea</i> (Cke) Sacc.) <i>Hawar pelepah or upih</i> (<i>Rhizoctonia solani</i> Khun.)

On the other hand, *Pyricularia grisea* (Cke) Sacc. blast caused the blast infection (Figure 1.B). It started with the onset of symptoms on the leaves in the form of spots such as rhombus with a pointed tip. The center of the spots is gray or whitish, with a reddish brown or brown edge. This disease attacks on varieties Cimelati, Cigeulis, Pandan ungu, and Mekongga. The disease *H. oryzae* attacks the leaves of rice plants, with brown, oval-shaped brown spots spread evenly on the leaf surface with gray or white dots, gray or white dots in the middle of the spots. Young spots are dark brown or purplish-shaped size of sesame seeds. Different from *Xanthomonas campestris* pv. *oryzae* Dye, this disease attacks the Cimelati, Pandan ungu, and Mekongga varieties, as shown in Figure 1.C.

Disease in the generative phase

On the other hand, in the generative phase, there are at least six main different diseases which are identified (i.e., *Hawar daun bakteri*, *Blast*, *Bercak coklat*, *Gosong palsu*, *Hawar pelepah/ upih*, and *Bercak daun sempit*). *Hawar daun bakteri* was indicated from the leaves that are colored gray to yellow, folded, and rolled. In a severe state, the entire leaf rolls, withers, and dies. Cimelati, Cigeulis, Pandan ungu, and Mekongga varieties are susceptible to this strike (Figure 2.A).

While for the plants which were affected by the blast (Figure 2.B-C), the symptoms were indicated by the appearance of shaped leaves like a rhombus and a pointed tip (blast leaves). The center of the spots is gray or whitish. It usually has brown or reddish brown edges and heavily influences all the paddy varieties, i.e., Cimelati, Cigeulis, Pandan ungu, and Mekongga. Also, Figure 2.D shows the symptoms of *Helminthosporium oryzae* L which caused the leaves to have oval-shaped brown spots which spread evenly on the surface of leaves with gray or white dots. Similar to *Pyricularia grisea* (Cke) Sacc., *Helminthosporium oryzae* L may attack the four paddy

varieties, i.e., Cimelati, Cigeulis, Pandan ungu, and Mekongga.

On the other hand, the symptoms of *Cercospora miyake oryzae* begins with the stricken leaves with narrow patches lengthwise, reddish-brown, parallel to the leaf bone, and commonly attacks the *Cigeulis* variety (Figure 3.A). Whereas, as shown in Figure 3.B, the infection of *Rhizoctonia solani* Kuhn on the plant was indicated by the spotted formation on a gray-shaped oval-gray midrib and then gray-white with a brown fringe. This disease was typically found on the sheath or the leaf midrib, and sometime on leaf strands if the conditions are supportable for the development of pathogens. This disease is commonly found on the varieties of Cigeulis, Pandan ungu, and Mekongga. Further, as seen in Figure 3.C, the symptom of *Ustilaginoidea virens* (Cke) Tak indicated by turning the strained rice seeds into golden spores of golden spores and sometimes green. In most cases, this disease attacks Cimelati variety, and only a few grains of rice was discovered on the panicle.

From a different perspective, based on the results of the macroscopical observations, the colony of the bacteria *Xanthomonas campestris* pv. *Dye oryzae* was identified by the appearance of rounded convex with a yellow surface area, as presented in Figure 4.A and 4.B. While Figure 4.C presented the isolation of microcystic observation of *bacilli* colony from fungus *Pyricularia grisea* (Cke) Sacc. Based on the microscopic observation, the fungus seemed to have a long, sparse, single, and gray-colored conidiophore, which formed a conidium at the end. As shown in Figure 4.D, conidium looked like as an oval with a pointed tip and was insulated into three room with gram-negative color (red). While Figure 4.E indicated the colonies of *Helminthosporium oryzae* L., which appears to be white on the fourth day. With microscopic observation, this fungus is seen to have a slightly curved *Conidia* (curve), enlarged in the center, smeared, brownish, and germinated from both end cells (Figure 4.F).



Figure 1. A. The symptom of *hawar daun bakteri* in vegetative phase. B. The symptom of *blast* in vegetative phase. C. The symptom of *bercak coklat* in vegetative phase

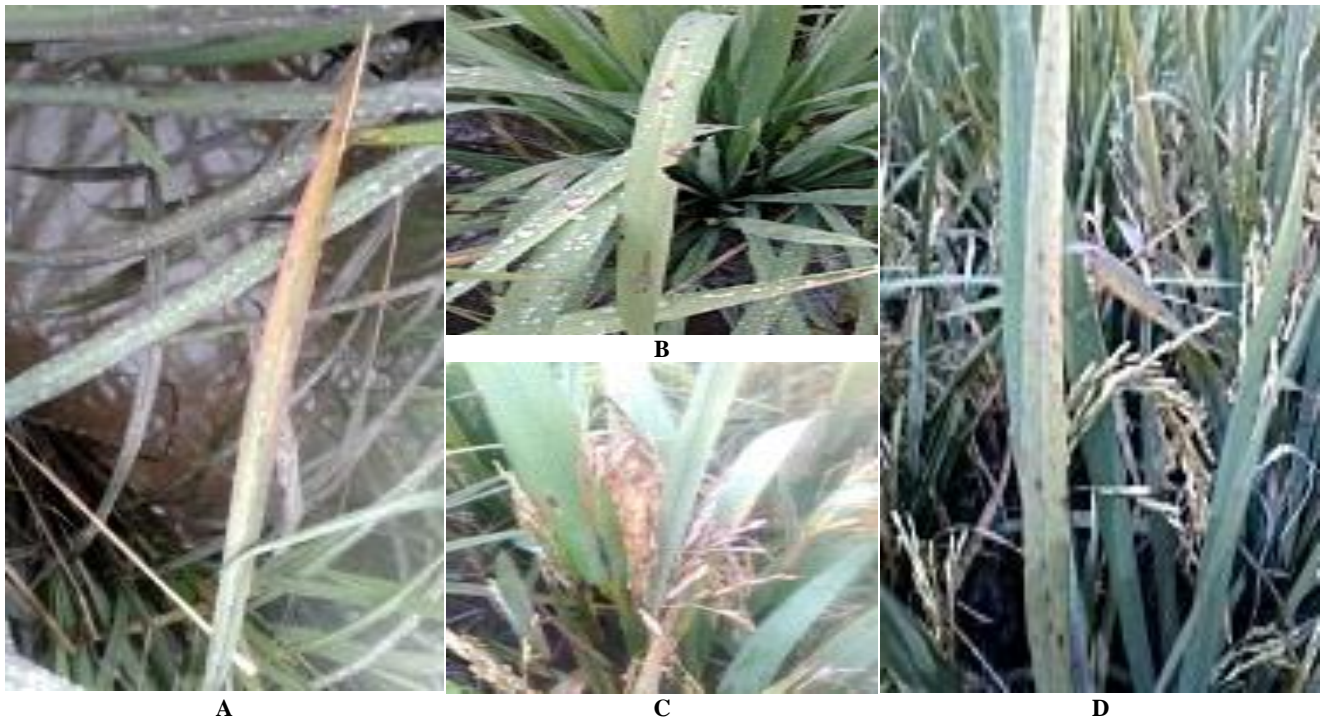


Figure 2.A. The symptom of *Hawar daun bakteri* in generative phase, B. The symptom of *blast* leaves, C. The symptom of neck blast, D. The symptom of *bercak coklat* in generative phase



Figure 3.A. The symptom of *bercak daun sempit* in generative phase. B. The symptom of *hawar pelepah/ upih* in generative phase. C. The symptom of *gosong palsu* in generative phase

As seen in Figure 5.A and 5.B, the colony of the fungus *Cercospora oryzae* Miyake appeared to be grayish and had a white colored on the fourth day, and by using microscopic observation, the fungus seemed to have cylindrical conidia which consisting of 3 - 10 septa, brown conidiophore, and growing on individual patches, where the conidium was formed on top of a conidiophore. While Figure 5.C and 5.D implied the colonies of the *Rhizoctonia solani* Kuhn fungus. It was likely to be white, and this fungus was capped with hyphens in and many branches. The colony of *Ustilaginoidea virens* (Cke) Tak. appeared to be grayish-brown on the fourth day. Microscopically, this

fungus has a spore, spiked, and germinated by forming a smaller secondary conidium and hyaline where the wind propels the conidium. Further, the highest spore production occurs at night where the hyphae are attached. The form is an oval-shaped lump and has propagules (Figure 5.E-F).

Discussion

Hawar daun bakteri

In this study, it revealed that the bacteria which caused the *Hawar Daun Bakteri* (HBD) disease is *Xanthomonas campestris* pv. *oryzae* Dye. The bacteria of *Xanthomonas campestris* pv. *oryzae* Dye. is a significant disease in many

rice-producing countries. The main reason is that HDB can reduce the rice yields at a different level of degrees, depending on the growth stage of the infected plants, and also the surrounding environment (Sopialena and Palupi 2017). Regarding the characteristics, the *Xanthomonas* is a slimy colony and produces yellow xanthomonadin pigments (Cao et al. 2018). HDB disease often occurs in the rainy season, especially when there is a strong wind, which plays a role in the transmission and its spreading. Meanwhile, persistently irrigated crops may create the environmental conditions which lead the disease to develop better (Bansal et al. 2017). Similarly, the cropping arrangement which is too rigid, provide a massive influence on the development of the disease. Conversely, the planting with far distance also allows the transmission from one plant to another. The jolt and tipping between the infected leaves and the healthy ones may trigger the rate of pathogen infection.

According to Abadi (2003), the characteristics of bacteria are short stems, rarely seen in pairs and having a

size of (1-2) x (0.8-1) μm . It has one polar flagellum with the size of 6-8 μm which serves as a mobile device. These bacteria are characterized by a narrow host range (Albuquerque et al. 2011) and considered as aerobic and can produce *extracellular polysaccharides* (EPS) which have an essential influence to cause the exudate which may infect the leaves. The *Xanthomonas* are slimy colonies, and generating a yellow pigment which may differ from another genus, i.e., *Pseudomonas* sp. *Xanthomonas* enter the plant tissue through the hydathoda which may happen at the leaf edge, broken roots, or the cut of the leaves. Seeds, farming tools, infected tillers, and weeds could be the primary cause for the bacterial inoculum, and the moist on the leaf surface can dissolve the bacterial cells and make it spreading freely. Akhavan et al. (2013) and Karavina et al. (2011) suggesting that wind, rain and irrigation channels may help the spread of the inoculum also. The bacteria can survive in the soil for 1-3 months, or 7-8 months in the seed.

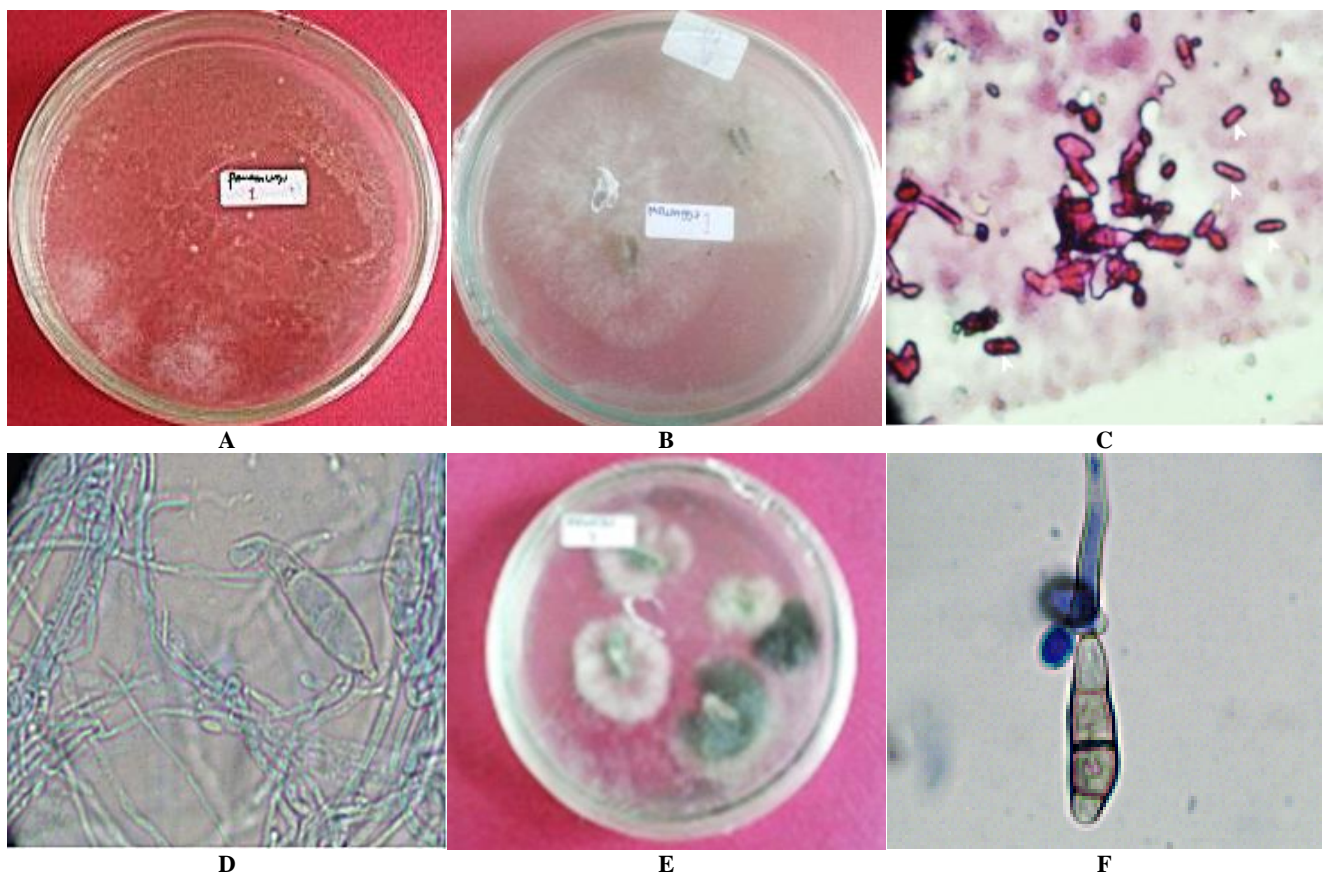


Figure 4. A. the colony of *Xanthomonas campestris* pv. *oryzae* Dye. B. *Pyricularia grisae* (Cke) Sacc. Colony. C. bacilli bacteria in gram negative color (400x). D. *Pyricularia grisae* (Cke) Sacc. (400x) conidia. E. Koloni jamur *Helminthosporium oryzae* L. *helminthosporium oryzae* L. (400x) conidia.

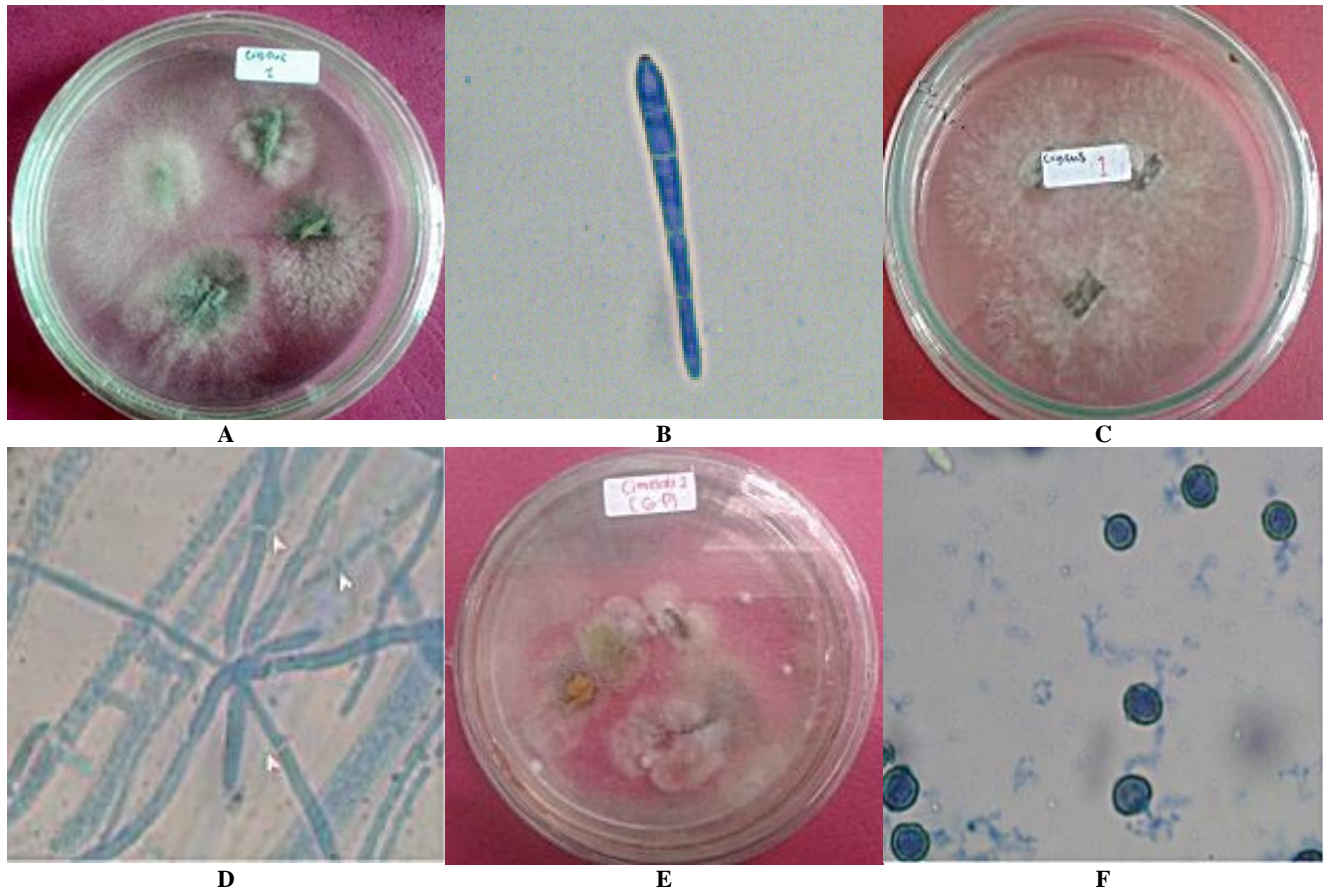


Figure 5.A. *Cercospora oryzae* Miyake. colony, B. *Cercospora oryzae* Miyake. (400x) conidia, C. *Rhizoctonia solani* Kuhn. Colony, D. *Rhizoctonia solani* Kuhn. (400x) hypha, E. *Ustilaginoidea virens* (Cke) Tak colony, F. *Ustilaginoidea virens* (Cke) Tak. (400x) spores

Blast (Pyricularia grisea (Cke) Sacc.)

The pyricularia grisea (Cke) Sacc. is found on all of the paddy varieties in tidal rice fields, and may infect either in the vegetative and generative phases. *P. oryzae* showed good growth at room temperature and optimum at the temperature ranging from 25-30 °C (Channakeshava and Pankaja 2018). *P. grisea* (Cke) Sacc works by disturbing the growth process. It initially infected the young leaves and forced the leaves to become dry and die. When the disease attacks in the growth phase, it is likely to cause *puso* (crop failure), particularly for vulnerable variety. However, it does not result in excessive yield loss if the infection occurs in the the phase of tiller development. The use of Si application also indicated a positive effect to reduce the intensity of leaf and neck blast attack, in particular for Ciherang variety (Siregar et al. 2016). Also, Amir et al (2003) and reported that the blast neck might potentially damage the rice crop if there are ample moistures at the beginning of flowering; either happening in morning or afternoon. In such climatic conditions, the temperature is not becoming the limiting factor. At a temperature of 30°C - 32°C, the neck blast is still capable of forming itself. There was a report mentioning that in Southeast Sulawesi, neck blast has infected the IR42

variety (at the average paddy age is two months) within the area of 300 ha. The main reason is that it was planted with a relatively high population, and there was much dew/moisture at the beginning of the flowering season.

Bercak coklat (Helminthosporium oryzae L.)

Helminthosporium oryzae L. appeared to attack the four local paddy varieties either in the vegetative or generative stage. According to Iqbal et al. (2015), the main indication of the disease seen on leaves and later found on young seedling and panicle branches in older plants. The most severe symptoms can come into sight approximately one month before the harvest. *Bercak coklat* affects the leaves and grains which could reduce the quality. The infection passed through stomata or directly the epidermal cell wall after forming appressoria. The fungus may survive longer in plant tissue, depending on the supporting environment (Hafiz et al. 2015). The codinia of *H. oryzae* has specific characteristics, i.e., having a brown color, insulated into 6-17 parts, cylindrical shape, slightly curved, and somewhat widened in the middle. Environmental factors, i.e., wind speed and sunshine hours are the most decisive factor for the epidemic development. (Biswas et al. 2018). Further, *H. oryzae* lives as a parasite, which may

destroy the sprouts and fruit, and cause a blemish on the host's leaf. The life cycle of this disease begins with a fungal conidium propagated by the wind and infection occurs through the mouth of the skin, while a new symptom may emerge 30 days or more after infection.

Bercak daun sempit (Cercospora oryzae Miyake.)

This study found that *Cercospora oryzae* Miyake appeared in the Cigeulis variety and occurred in the generative phase. According to Mahmud et al (2018), *C. oryzae* is a very harmful disease because it could damage the production, by drying the leaves before the time and harm the midrib. The spots mostly increased at seedlings. In severe attacks, *bercak daun sempit* is visible on leaves, stems, and flowers. However, when the plant starts to ripen, the heavy symptoms begin to appear on the flag leaves. In most cases, the severe symptoms cause the leaves to dry out. On the other hand, the infections which happen in the midrib and stem may initiate the stem and rot leaves which make the plant becoming collapsed (Wahyuno et al. 2017).

The disease usually transmits through the air and an alternating host. The hot air temperature and interspersed with rain is likely to accelerate the growth of the fungus, of which the fungus generate *bercak daun sempit* (Purnomo 2013). The infection happens through stomata, and new symptoms may appear about 30 days or more after the contamination. The symptom passes slowly even for young plants. However, the time of formation and filling of the panicles is the most vulnerable time for the entire stage.

Hawar pelepah/upih (Rhizoctonia solani Kuhn.)

Rhizoctonia solani Kuhn. came across in Cigeulis variety, Pandan ungu, and Mekongga and occurred in the generative phase. What is more, many species of *Rhizoctonia* cause important diseases (Bolton et al. 2010; Madbouly et al. 2014). It can subsist in the soil, where the perennial plants existing and can transform in dormant structures when the host plant is unattainable (Tirtana 2013). Though the dispersion of the pathogens can pass through the parts of plants which buried in the soil, seeds also further the spreading across rainwater, irrigation flows or floods. The use of agricultural tools which contaminated these pathogens from the soil turns to be a common way of dispersal. The ideal temperature for most of this fungus is 15° to 18°C. However, a small number of them can grow up to 35°C. The consequence of *Hawar pelepah* infection is decelerating the plant growth. When it grows in Potato Dextrose agar medium (PDA), the mycelium will initially appear white, and gradually the color of mycelium turns into light brown to old.

Gosong palsu (Ustilaginoidea virens (Cke) Tak.)

The *Ustilaginoidea virens* (Cke) Tak. was found in *Cimelati* variety and happen in the generative phase. It is a disease-causing pathogenic fungus, formerly also known as *Ustilago virens* (Cke) Tak. Conidia are seen in an oval shape, very small, and have several green spore balls form sclerotia in the middle. The sclerotia can endure in the winter and flourish by spring. The fungus seems to be a

solid, soft and yellow-covered membrane, and the color changes from yellow to orange, yellowish green and eventually into a greenish black.

Gosong palsu diseases occur in the rice grains. The fungus turns the panicle grains into a greenish-yellow spore where it looks like velvet. The spores are initially small and visible among the glomes and covered with a membrane which as a result of further growth. The color of the spore ball becomes orange and then turns greenish to greenish. At this stage, when the surface of the spore bulb is broken, the outer layer of the ball will consist of mature spores along with the remaining fragments of mycelium. It has three layers of which, for the outermost layer, the green spore is blackish, the middle layer is orange, and the inner layer is yellow. According to Fan et al (2015) pathogen *U. virens* (Cke) Tak. produces a toxin known as Ustiloxins. Ustiloxins are tetra peptidesunik and Ustiloxins A-F which is isolated from *gosong palsu* spore water extract. Toxins cause mycotoxicosis and may inhibit brain tubulin polymerization at micromolar concentrations. Pathogens can produce sclerotia in the life cycle stage, which germinate and produce Asco spore that will infect at the beginning of flowering. The continued of the infection is an important part of the cycle of *gosong palsu* disease.

Gosong palsu diseases are prevalent in humid weather. In relatively high humidity, low temperature, and precipitation accompanied by cloudy days during flowering rice plants are favorable for the fungus *U. virens* (Cke) Tak. *Gosong palsu* disease develops in the rice husk and turns the rice endosperm into a large fungal sclerotium, which protrudes to the outside, golden yellow. Usually, in one panicle, there are only a few grains of rice that are exposed to the conidium emitted by wind and spores are present in the air around the night, while in the daytime very little. In general, the infection can occur, before or after the fertilization in panicle seed.

To this end, this study provided a better understanding on the types of paddy diseases and it's natural occurring to four different paddy varieties in Kutai Kartanegara, Indonesia. The information is useful for the farmers to predict the and identify the appropriate diseases management to paddy planting. *Gosong palsu* was commonly found in Cimelati variety, but *Hawar pelepah/upih* emerged in Cigeulis, Pandan ungu, and Mekongga varieties. Further, Cigeulis was susceptible to *bercak daun sempit*, while the rest of four paddy varieties were susceptible to *Bercak daun coklat*, *blast*, and *hawar daun bakteri*.

REFERENCES

- Abadi, L.A. 2003. *Pertahanan Tumbuhan dalam Ilmu Penyakit Tumbuhan*. Malang: Bayumedia Publishing dan Fakultas Pertanian Universitas Brawijaya
- Akhavan A, Bahar M, Askarian H, Lak MR, Nazemi A, Zamani Z. 2013. Bean common bacterial blight: pathogen epiphytic life and effect of irrigation practices. *Springerplus* 2(1):41.
- Albuquerque P, Caridade CM, Marcal AR, et al. 2011. Identification of *Xanthomonas fragariae*, *Xanthomonas axonopodis* pv. *phaseoli*, and *Xanthomonas fuscans* subsp. *fuscans* with novel markers and using a

- dot blot platform coupled with automatic data analysis. *Appl Environ Microbiol* 77(16):5619-28.
- Amir, M, Santoso, A Nasution, dan B Kusdianto. 2003. Pemetaan *Pyricularia grisea* di Daerah Endemik Blas di Sentra Produksi Padi Sawah dan Padi Gogo. Laporan Akhir Tahun Balitpa, Balitbangtan, Departemen Pertanian.
- Ariyanto EF, Abadi AL, Djauhari S. 2013. Keanekaragaman jamur endofit pada daun tanaman padi (*Oryza sativa* L.) dengan sistem pengelolaan hama terpadu (PHT) dan konvensional di Desa Bayem, Kecamatan Kasembon, Kabupaten Malang. *Jurnal HPT* 1(2): 37-51
- Badan Pusat Statistik. 2016. Statistik Indonesia. BPS-Statistics Indonesia
- Bansal K, Midha S, Kumar S, Patil PB. 2017. Ecological and evolutionary insights into *Xanthomonas citri* pathovar diversity. *Appl Environ Microbiol* 83:e02993-16
- Bantacut T. 2014. Indonesian Staple Food Adaptations For Sustainability in Continuously Changing Climates 4.
- Biswas MK, Quiry S, Ghosh T. 2018. Role of abiotic factors on the development of rice Brown spot caused by *bipolaris oryzae* (breda de haan) shoemaker. *Bionature* 38(2): 86-95.
- Bolton MD, Panella L, Campbell L, Khan MFR. 2010. Temperature, Moisture, and Fungicide Effects in Managing *Rhizoctonia* Root and Crown Rot of Sugar Beet. *Phytopathology* 100:689-697
- Cao XQ, Wang JY, Zhou L, Chen B, Jin Y, He YW. 2018. Biosynthesis of the yellow xanthomonadin pigments involves an ATP-dependent 3-hydroxybenzoic acid: acyl carrier protein ligase and an unusual type II polyketide synthase pathway. *Mol Microbiol* 110(1): 16-32
- Channakeshava C, Pankaja NS. 2018. Effect of Media, Temperature, Light, pH and Nutrient Source on Growth and Development of *Bipolaris oryzae* Causing Brown Leaf Spot of Paddy. *Int.J.Curr.Microbiol.App.Sci.* 7(7): 1713-1722
- Dinas Pangan, Tanaman pangan dan hortikultura. 2017. Laporan Tahunan. Dinas Pangan, Tanaman pangan dan hortikultur Provinsi Kalimantan Timur.
- Fan J, Guo XY, Li L, Huang F, Sun WX, Li Y, Huang YY, Xu YJ, ShiJ, Lei Y, Zheng AP, Wang WM. 2015. Infection of *Ustilagoidea virens* intercepts rice seed formation but activates grain-filling-related genes. *J Integr Plant Biol* 57: 577-590
- Gao F, Dai C, Liu X. 2010. Mechanisms of Fungal Endophytes in Plant Protection against Pathogens. *African Journal of Microbiology Research* 4 (13): 1346-1351.
- Iqbal MF, Hussain M, Waqar MQ. 2015. Evaluation of best fungicide for controlling brown leaf spot in transplanted rice. *Int. J. Adv. Res. Biol. Sci* 2(7): 44-48
- Jayanthi P, Edirisinghe, Channa NBB. 2006. Rice fields: an ecosystem rich in biodiversity. *J.Natn. Sci. Foundation Srilanka* 34(2):57-59.
- Karavina C, Mandumbu R, Parwada C, Tibugari H. 2011. A review of the occurrence, biology and management of common bacterial blight. *Journal of Agricultural Technology* 7(6): 1459-1474.
- Kihoro J, Bosco NJ, Murage H, Ateka E, Makihara D. 2013. Investigating the impact of rice blast disease on the livelihood of the local farmers in greater Mwea region of Kenya. *SpringerPlus* 2(1): 308.
- Madbouly AK, Boari A, Vurro M, Gebreel HM, Abouzeid MA. 2014. Biocontrol of *Rhizoctonia solani* causing stem canker disease of potato using rhizosphere mold fungi. *International Journal of Agronomy and Agricultural Research* 4(6): 34-45.
- Mahmud H, Hossain I, Ahmad MU. 2018. Plant Extracts, BAU-Biofungicide and Fungicides in Controlling Some Important Diseases of Rice cv. BRR1 Dhan40. *Am J Phytomed Clin Ther* 6(2):7
- Mareza E, Djafar ZR, Suwignyo RA, Wijaya A. 2016. Rice ratoon yield response to main crops cutting height in tidal swamp using direct seeding system. *Agrivitas Journal of Agricultural Science* 38(2): 126-132
- Purnomo B. 2013. Organisme Pengganggu Utama Pada Tanaman Padi dan Cara Pengendaliannya. Koordinasi Penanggulangan OPT/DPT Padi 27-28 Juni 2013. Prov. Bengkulu
- Remans R, Wood SA, Saha N, Anderman TL, DeFries RS. 2014. Measuring nutritional diversity of national food supplies. *Global Food Security* 3(3-4):174-82.
- Rodriguez RJ, White JF, Arnold AE, Redman RS. 2009. Fungal endophytes: diversity and functional roles. *New Phytologist*. 182:314-330.
- Saunders M, Glenn AE, Kohn LM. 2010. Exploring the evolutionary ecology of fungal endophytes in agricultural systems: using functional traits to reveal mechanisms in community processes. *Evol Appl* 3: 525-537.
- Setyo P, Elly J. 2018. Problems Analysis on Increasing Rice Production Through Food Estate Program in Bulungan Regency, North Kalimantan. *IOP Conf. Ser.: Earth Environ. Sci.* 147 012043
- Siregar AF, Husnain, Sato K, Wakatsuki T, Masunaga T. 2016. Empirical Study on Effect of Silicon Application on Rice Blast Disease and Plant Morphology in Indonesia. *Journal of Agriculture Science* 8(6): 137-148
- Sopialena, Pratiwi JP. 2017. Study of climatic factors on the population dynamics of *Pyricularia oryzae* on some varieties of paddy rize (*Oryza sativa*). *Biodiversitas* 18(2): 701-708.
- Sopialena, Suyadi, Sahil M, Nurdiana J. 2018a. The diversity of endophytic fungi associated with *Piper nigrum* in the tropical areas: a recent study from Kutai Kartanegara, Indonesia. *Biodiversitas* 19(6): 2028-2034
- Sopialena, Surya S, Rosfiansyah, Nurdiana J. 2018b. The role of neem leaves as organic pesticides in chili pepper (*Capsium frutescens*). *Nusantara Bioscience* 10(4): 246-250
- Stringer, Christina E.; Krauss, Ken W.; Latimer, James S., eds. 2016. Headwaters to estuaries: advances in watershed science and management—Proceedings of the Fifth Interagency Conference on Research in the Watersheds. March 2-5, 2015, North Charleston, South Carolina. e-Gen. Tech. Rep. SRS-211. Asheville, NC: U.S. Department of Agriculture Forest Service, Southern Research Station. 302 p.
- Susilastuti D. 2018. The effect of jarak legowo planting system on Ciherang paddy varieties. *Agritropica* 1(1-8).
- Suyadi, Sopialena, Nurdiana J, Suryadi A, Rosfiansyah, Waluyo S. 2017. Genus Nematoda Entomoparogen pada lahan lebak padi sawah (*Oryza sativa* L.) di kecamatan Muara Wis Kabupaten Kutai Kartanegara. *Proceeding of Konferensi Antarbangsa Islam Borneo. Mulawarman University, Samarinda, 25 September 2017.*
- Tirtana ZYG, Sulistyowati L, Cholil A. 2013. Eksplorasi jamur endofit pada tanaman kentang (*solanum tuberosum* L) serta potensi antagonismenya terhadap *phytophthora infestans* (Mont.) De Barry penyebab penyakit hawar daun secara in vitro. *Jurnal HPT* 1(3): 91-101
- Wahyuno D, Florina D, Manohara D. 2017. Cendawan endofit akar lada untuk meningkatkan pertumbuhan dan menekan busuk pangkal batang benih lada. *Balai Penelitian Tanaman Rempah dan Obat* 28(1) : 57-64
- Widyanti A, Sunaryo I, Kumalasari AD. 2014. Reducing the dependency on rice staple food in Indonesia- a behavior intervention approach. *J. ISSAAS* 20(1): 93-103
- Chang X., DeFries RS, Liu L, Davis K. 2018. Understanding dietary and staple food transitions in China from multiple scales. *PLoS one*, 13(4), e0195775.
- Zhang H, Xu F, Hu H, Dai X. 2017. Progress of potato staple food research and industry development in China. *Journal of Integrative Agriculture* 16(12): 2924-2932