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Identification of Pests and Diseases on Coconut (*Cocos nucifera* L.) in Sangihe Island Regency, North Sulawesi Province, Indonesia

Identifikasi Hama dan Penyakit pada Tanaman Kelapa (Cocos nucifera L.) di Kabupaten Kepulauan Sangihe, Provinsi Sulawesi Utara, Indonesia

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ABSTRAK

Sebagai sebuah wilayah kepulauan, Kabupaten Kepulauan Sangihe dikenal memiliki hamparan perkebunan kelapa yang menjadi komoditas andalan dan sumber pendapatan masyarakat lokal. Inventarisasi hama dan penyakit yang spesifik pada tanaman kelapa di wilayah ini belum pernah dilakukan, sedangkan informasi tersebut dibutuhkan terutama dalam hal pengelolaan kelapa yang berkelanjutan. Penelitian ini bertujuan untuk mengetahui keberadaan hama dan penyakit tanaman kelapa di Kepulauan Sangihe serta mendapatkan kondisi terkini terkait serangan hama dan insidensi penyakit. Penelitian dilakukan melalui beberapa tahap, yaitu wawancara kepada petani, pengambilan sampel tanaman bergejala, dan identifikasi serta dokumentasi hama dan penyakit. Iklim Kepulauan Sangihe tergolong ke dalam tipe A (sangat basah) dengan rata-rata curah hujan 248 mm, suhu 27 °C, dan kelembapan 83% dalam kurun waktu 2017-2021. Kondisi tersebut menjadi salah satu faktor penentu eksistensi serangan hama dan infeksi patogen penyebab penyakit pada tanaman kelapa. Hama mendominasi sebagai organisme pengganggu dibandingkan penyakit yang disebabkan oleh patogen tumbuhan. Hama yang ditemukan yaitu belalang, kumbang tanduk, kumbang janur, kumbang bibit, tungau kelapa, kutu perisai, dan tikus ekor putih. Pengamatan luas dan intensitas kerusakan oleh belalang (*Sexava coriaceae*) dilakukan di Kecamatan Tahuna Barat dengan memilih tiga kategori lahan. Kerusakan tertinggi terjadi di lahan B (sebagian besar ditanami Kelapa Hibrida) dengan persentase sebesar 39%, sedangkan kerusakan terendah di lahan C (sebagian besar ditanami Kelapa Dalam), yaitu 17%. Penyakit utama yang ditemukan adalah penyakit bercak daun kelabu yang disebabkan oleh cendawan *Pestalotiopsis palmarum*. Insidensi dan keparahan penyakit tertinggi ditemukan di Kecamatan Tabukan Utara dengan persentase masing-masing 43% dan 22%, sedangkan insidensi dan keparahan terendah ditemukan di Kecamatan Tahuna Barat dengan persentase masing-masing 3% dan 1%.

Kata Kunci:

cendawan;

gejala serangan;

intensitas kerusakan;

serangan hama.

ABSTRACT

As an archipelago regency, the Sangihe Islands has been known for its expanses of coconut plantations, which are one of the local community's primary commodities and sources of income. An inventory of pests and diseases specific to coconut in this area has never been carried out, and this information is needed, especially regarding sustainable coconut management. This study aimed to determine the presence of coconut pests and diseases in Sangihe and to obtain the latest conditions related to pests and disease incidence. The research was carried out through several stages, i.e., interviewing farmers, sampling, and identifying and documenting pests and diseases. The climate condition of Sangihe Island is classified as type A (very wet), with an average rainfall of 248 mm, temperature of 27 C, and humidity of 83% from 2017-2021. This condition is one of the determining factors for the existence of pest attacks and disease-causing pathogen infection on coconut. Pests dominated as disturbing organisms compared to diseases caused by plant pathogens. These pests included grasshoppers, coconut rhinoceros beetles, coconut hispine beetles, coconut mites, and white-tailed mice. Observations of the damage intensity by Sexava coriaceae were conducted in the Tahuna Barat district by selecting three land categories. The most severe damage occurred in field B (mostly planted with Hybrid Coconuts) with a percentage of 39%, while the lowest damage was in field C (mostly planted with Tall Coconuts), at 17%. The major disease detected was a gray leaf spot caused by the fungus Pestalotiopsis palmarum. The highest disease incidence and severity were found in Tabukan Utara district with percentages of 43% and 22% respectively, while the lowest incidence and severity were found in Tahuna Barat district with percentages of 3% and 1%, respectively.

Keywords:

Fungus,

attack symptoms,

damage intensity,

pest attacks.

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INTRODUCTION

Sangihe Islands Regency is one of the coconut production centers in North Sulawesi province. Coconut is essential in supporting this regency's economy, specifically as a source of community income and a provider of employment. Based on data released by the Indonesia Central Bureau of Statistics (2019), the coconut area in Sangihe Islands in 2018 was 25,171 ha with a total production of 23,110 tons and contributed approximately 8.90% of the total coconut production in North Sulawesi (Directorate General of Plantation, 2021). Coconut production in the Sangihe Islands in 2015-2018 fluctuated relatively. The production in 2015 was around 20 thousand tons and decreased to 11 thousand tons in 2016. In 2017, there was an increase in production (23 thousand tons), but it declined again in 2018 with a small gap.

As an annual crop, coconut (*Cocos nucifera* L.) grows and produces well in particular environmental circumstances, especially in the tropics. However, Indonesia still faces significant barriers to coconut cultivation, including aging plants, poor quality of planting materials, and pest and disease occurrence in the fields. Several studies have reported on coconut pests and diseases in Indonesia. Alouw & Wulandari (2020) reported three top significant pests in coconut fields, i.e., *Oryctes rhinoceros*, *Brontispa longissima*, and *Sexava* spp., while root rot and fruit drop were the diseases with the highest frequency in Indonesia. In addition to pests and diseases, Gurbuz & Manaros (2019) found that coconut production was strongly influenced by several other factors, such as farmers' educational background, land size (in hectares), number of coconut plants grown per hectare, and frequency of harvesting. Furthermore, the investigation results of Hebbar et al. (2022) showed that climate change dramatically affected the adaptation of coconut plants to their growing environment.

The relatively large coconut plantation area in the Sangihe Islands needs to be supported by a good production system, including efforts to control pests and diseases appearing at several locations. So far, information on pest attacks and pathogen infections that cause diseases in coconut plants in the Sangihe Islands and their status has yet to be available. It is due to several factors, one of which is conventional coconut cultivation, which smallholders dominate. The Directorate General of Plantation (2021) reported that 99% of the national coconut area was smallholder plantations. As a result, there is a lack of detailed information about pests and diseases of coconut in the Sangihe Islands. Therefore, this study aims to inventory pests and diseases of coconut plants in the Sangihe Islands district and determine their current status.

METHODOLOGY

The research was conducted from January to April 2022 in four districts in the Sangihe Islands Regency. The districts were Tabukan Utara, Tabukan Tengah, Tahuna Barat, and Tabukan Selatan Tengah. Pests and disease identification were carried out at the Pests and Disease Laboratory, Indonesian Palmae Crops Research Institute, and Laboratory of Plant Mycology, IPB University. In this study, interviews were also conducted with farmers to obtain an overview of their characteristics, such as age, educational background, and other occupations. Observations were conducted on two types of coconut plantations, namely Tall Coconut and Hybrid Coconut with three plantations in each district. The area of the plantation selected as the observation plot was 2500-5000 m^2, with the number of coconut trees in the plantation ≥50 plants. All plants in the plots were taken as samples. The percentage of plants attacked

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by pests was calculated using the following formula:

$$API = \frac{n}{N}\ x\ 100\%$$

Description: APA = area of pest attacks; n = the number of attacked plants; N = the total number of sample plants observed.

The percentage of damage was calculated based on Balitka (1990) by randomly selecting ten plants in a coconut plantation infested by *S. coriacea*. Those trees were climbed and the midrib at the center of the crown was cut. In addition to the midrib, leaflets 20 and 40 on the young midrib were taken without cutting the midrib. Leaf damage was calculated by measuring the eaten leaf area of the 20th and 40th leaflets on the young midrib and the 20th, 40th, 60th, and 80th leaflets on the midrib. The leaflet number was calculated from the base of the midrib.

Disease incidence was calculated using the following formula (Cooke, 2006):

$$DSI = \frac{n}{N}\ x\ 100\%$$

Description: DSI = disease incidence; n = the number of affected plants; N = the number of all sample plants observed.

Disease severity was calculated based on symptoms using the Towsend & Heuberger (1943) formula described in Agrios (2005) as follows:

$$DSS = \frac{\sum[ni \times vi]}{N \times V} \times 100\%$$

Description: DSS = disease severity; ni = the number of affected plants in category i; vi = i-th damage category (score); N = the number of observed plants; V = highest attack category score.

RESULT AND DISCUSSION

General condition of the study area

Geographically, Sangihe Islands Regency is located at 20 4'13" - 40 44' 22" North latitude and 1250 9' 28" - 1250 56' 57" East longitude with an area of 736.98 km^2. Its position is between the islands of Sulawesi and Mindanao (Republic of the Philippines), so this regency is categorized as a border area (Indonesia Central Bureau of Statistics, 2019). The topographic conditions of the Sangihe Islands Regency are generally hills with steep slopes. Nevertheless, this area is utilized by the population to grow plantation crops, such as coconut (*Cocos nucifera*), nutmeg (*Myristica fragrans*), and cloves (*Syzigium aromaticum*). Soil types found in Sangihe Regency are dominated by latosol and alluvial soils. These two soil types are considered suitable for coconut plant growth (Mardiatmoko & Ariyanti, 2018).

The Sangihe Islands Regency consists of 15 districts, 12 districts are located on one island, while the other three are on different islands. The observation sites were located in the districts of Tabukan Utara, Tabukan Tengah, Tabukan Selatan Tengah, and Tahuna Barat (Figure 1).

Table 1. The severity score based on symptoms of coconut leaf spot disease (Rajeswari et al., 2020) with slight modifications

Scores	Attacks percentage (%)	Description
0	0	Healthy plant. No symptoms appear on the leaflets
1	< 10	Symptoms appear slightly on the leaf surface
2	11-25	Nearly a quarter of the leaflets are infected
3	26-50	Almost half of the leaflets are infected
4	51-75	More than half of the leaflets are infected. There is a change in the color of the leaf
5	> 75	Almost the entire leaf surface is infected

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Geographically, Tabukan Utara, Tabukan Tengah, and Tabukan Selatan Tengah districts are located on the east coast of Sangihe island. In contrast, the Tahuna Barat district is located on the west coast of the island.

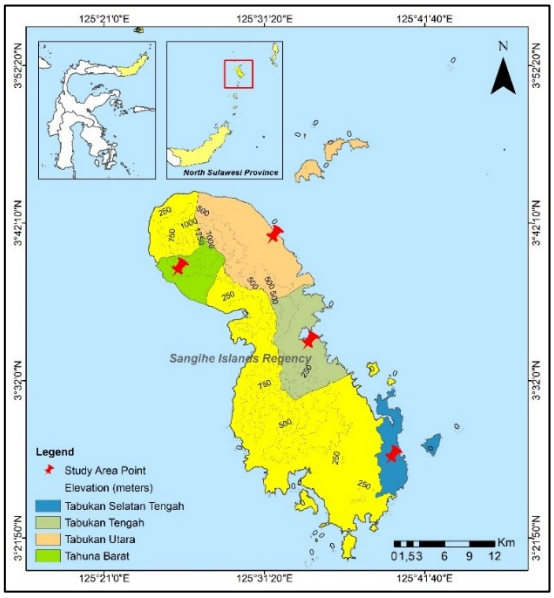

Figure 1. Map of the study area in Sangihe Islands Regency. Coconut plantations in four districts were observed

The climate conditions of the Sangihe Islands are strongly influenced by wind direction. Climate change during the west wind season usually occurs from October to December. While the south wind season usually occurs from June to August. Based on the Schmidt-Ferguson climate type, the climate of the Sangihe Islands is classified as a type A, which is a very wet climate with the tropical rainforest as its natural vegetation (Indonesia Central Bureau of Statistics, 2019). The Schmidt-Ferguson climate type is determined according to the average number of wet months and dry months in the study year (Sasminto et al., 2014). An overview of climatic conditions in Sangihe Regency over the past five years is shown in Table 2.

Sexava coriacea: the attack intensity in Tahuna Barat district

Sexava spp. is a pest endemic to eastern Indonesia, causing extensive damage to coconut and other palms. *Sexava* consists of four species, i.e., *Sexava nubila* Stal, *Sexava coriacea* L., *Sexava karnyi* Leefmans, and *Sexava novae-guineae* Brancsik (Kalshoven, 1981). However, Sabbatoellah & Hosang (2006) reported that only two species caused more damage to coconut palms, which were *S. nubila* and *S. Coriacea* –these species were characterized by the length of the ovipositor. The ovipositor of *S. nubila* was shorter compared to *S. coriacea*. During resting time, the ovipositor tip did not extend beyond the wing tip.

In the study area, *Sexava* spp was only found in Tahuna Barat district. The species of *Sexava* found were green and brownish-green *Sexava coriacea* (Figure 2A). The antennae were filiform and longer than the

Table 2. The average of rainfall, temperature, humidity, and sunshine duration in Sangihe Islands Regency, 2017-2021

Year	Rainfall (mm)	Temperature (°C)	Humidity (%)	Sunshine duration (%)
2017	189	24,5	85	57
2018	255	27,8	82	67
2019	184	27,7	81	72
2020	226	27,6	82,8	65
2021	384	27,6	84,6	61
Mean	248	27	83	64

Source: Indonesia Central Bureau of Statistics (2019, 2021)

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body. According to the morphological characteristics proposed by Hosang (2015), the species *Sexava* attacking coconut in the Tahuna Barat district were *coriacea*. This pest attacked coconut palms by eating the leaflets from the edges to the center and making uneven bite marks (Figure 2B). Coconuts with a severe attack on the leaves would only have sticks left, indirectly affecting fruit development. Hence, production became very low as most of the plants were not able to produce optimally. In addition to affecting the leaves, this pest also affected the coconut fruit, as shown in (Figure 2C). An attack on young fruit caused them to fall, thus reducing production

Observations were conducted on three coconut fields infested with *S. coriacea* (Table 4). The sites were located in the Tahuna Barat district, which is the center of *S. coriacea* attacks in the Sangihe Islands Regency. According to interviews, this pest was a common problem in coconut plantations in the Tahuna Barat district.

The results showed that the highest damage intensity was found in field B at 39% (Figure 3). The high intensity of damage in the field was due to the lack of weed removal by farmers. Land C, which was more frequent in mowing its weeds, had a lower attack area and damage intensity compared to land A and B. Hosang (2015) reported that weed removal was an indirect control of pest populations because it is likely to damage eggs around the coconut root.

Figure 2. Imago of *S. coriacea* (A), *S. coriacea* symptoms on leaves (B), symptoms on fruits (C).

Table 3. General condition of three observation sites in the Tahuna Barat district

Field Information	Field		
	A	B	C
Location	Near-shore	Near-shore	Near-shore
Land area	1650 m^2	1500 m^2	1240 m^2
Coconut types	Tall coconut	Hybrid coconut	Tall coconut
Plants age	60-80 years old	40 years old	60-80 years old
Frequency of weed removal	Once in 3 months	Once in 3-4 Months	Once a month
Fertilization	-	Yes	-
Intercroping	No	Banana	Papaya

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Unsanitary plantations would favor the pest population and thus the level of infestation in the field would be higher.

In addition to cultivation measures, attack levels are also influenced by other host plants. Other host plants of *Sexava* spp. were sugar palm (*Arenga pinnata*), banana (*Musa* sp.), and sago (*Metroxylon sagu*) (Hosang, 2015). These plants were found in the observation sites, particularly banana plants that were intercropped in field B. According to Warouw (1981), nymphs consuming a combination of coconut and banana leaves had a higher survival rate than those consuming only coconut leaves. The combination of food obtained by *S. coriacea* in field B was one of the factors influencing the high intensity of damage in that location.

Coconut Rhinoceros Beetle (*Oryctes rhinoceros*)

Oryctes rhinoceros is one of the common pests found in the field. We found this pest in four study areas. However, the intensity of damage was low despite being an essential pest of coconut in several regions of Indonesia, including Jepara Regency on Java Island and Riau Province on Sumatra Island (Indriyanti et al., 2019). This condition is thought to be due to an environment unfavorable to the beetle's life cycle, i.e., the lack of litter for egg-laying and larval breeding. The larvae of *O. rhinoceros* found were shaped like the letter C in whitish color with a capsule-like head in brown-reddish color (Figure 4B). According to Jackson et al. (2020), the imago had a body length of 30-40 mm, blackish-brown body color. Imago had black horns and generally, the horns of male beetles were longer than the horns of female beetles (Kalshoven, 1981). Rhinoceros attack caused unusual symptoms on the leaves and midribs of the coconut. Symptoms on the leaves were characterized by a "V" shaped cut similar to a scissor cut (Figure 4A). Frond damage was in the form of holes, made when the plant was young (Figure 4C). Jackson et al. (2020) reported that *O. rhinoceros* destroyed coconut plants by punching holes in young coconut leaves.

Coconut Hispine Beetle (*Brontispa longissima*)

B. longissima imago found on coconut plantations in Sangihe was characterized by brownish elytra on the thorax and a small part on the abdomen (Fig. 5A). According to Rahma & Alouw (2014), *B. longissima* that damage coconut plants were in the stages of the larvae and imago. Based on the results of field observations, *B. longissima* was not a significant pest in coconut plantations in Sangihe Islands. Symptoms of the attack found in the field were brown elongated rattling on coconut leaves that were starting to bear fruit (Figure 5B). Affected leaves become

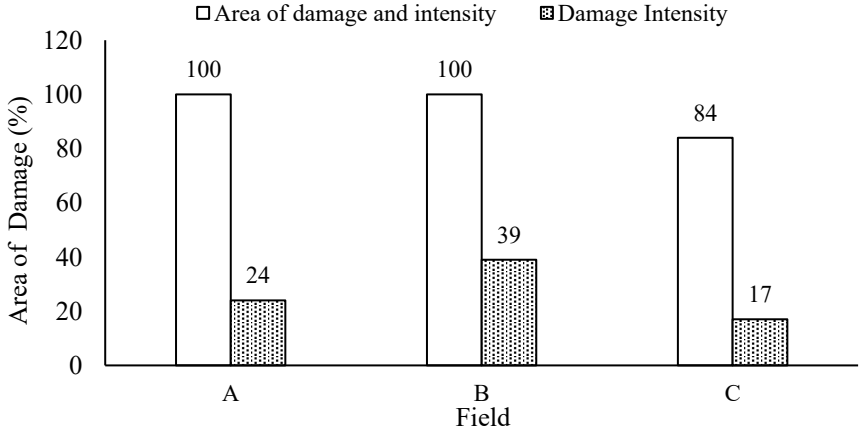

Figure 3. Damage area and intensity of *S. coriacea* in three observation sites.

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Figure 4. Symptoms caused by *O. rhinoceros* on leaves (A), larvae of *O. rhinoceros* (B), Symptoms on the midrib of coconut (C).

wrinkled and dry after opening. Damage to plant leaves affects coconut. According to Alouw & Hosang (2008) crop production can drop by up to 40% when leaf damage reaches 20%. Leaf damage on young plants caused plant growth to become stunted, and heavy attacks killed the plant.

Coconut Mites (*Aceria guerreronis*)

Aceria guerreronis of the Eriophyidae family was a pest destroying coconut fruit and flowers (Sarkar, 2011). In the field, *A. guerreronis* was found attacking young coconuts. This pest attack caused the fruit to fall, so it could not be harvested. The characteristic of this pest was an elongated body shape like a worm. The eggs of *A. guerreronis* were oval and white (Figure 6A). According to Navia et al. (2005), female imago body length ranged from 205–255 µm. Symptoms of coconut mite attack on coconut fruit could be identified by looking at the small, pale triangular shape on the surface of the young fruit (Figure 6B). According to Salim & Hosang (2013) this pest attacked and developed in the meristematic tissue and then sucked the soft coconut tissue under the fruit petals. The affected fruit was initially pale and then turned brown as the fruit developed.

Rat (*Maxomys hellwandii*) attacks the coconut plantation

The rat belongs to the Class Mammalia, Order Rodentia, Suborder Myomorpha, Family Muridae, and Sub-Family Murinae. Rats are wild animals that often become a problem for farmers of several commodities such as food, plantations, and horticulture. The characteristic symptoms of a rat infestation on fruit are holes with uneven edges near the upper fruit's base (Figure 7). Attacks were found in all observation sites with relatively low levels of damage. Based on the symptom and sign characteristics, it was likely that the rats presented in the fields were white-tailed.

Residents often hunt this rat for consumption. White-tailed rats (*Maxomys hellwandii*) were endemic to the forests of Sulawesi Island (Upa et al., 2017). It is characterized by the color of the ventral body and tail. Half of the tail was white while the other part was brown (Ikhsan, 2020).

Gray leaf spot disease

The gray leaf spot disease found in the study area infects coconut seedlings and productive coconut trees. Kittimorak et al. (2013) reported that gray leaf spot disease infestation could cause more than 50% damage to coconut plantations. Coconut plant

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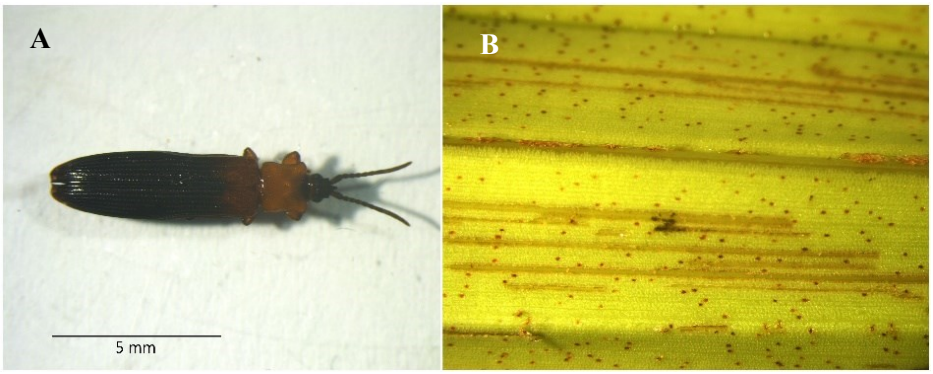

Figure 5. Imago *B. longissima* (A), symptom on the leaf caused by *B. longissima* (B).

Figure 6. Imago and eggs of *A. guerreronis* (A), Symptom on coconut fruit (B).

Figure 7. Symptom on coconut fruit caused by rats (*Maxomys hellwandii*).

infected with gray leaf spot disease showed early symptoms of small yellowish lesions. After the lesions enlarge, the color changed to brown and black-brown with a yellow halo at the edges of the lesions (Figure 8A). Bhuiyan et al. (2021) reported that gray leaf spot disease showed symptoms on leaves in the form of spots with a yellow halo and the center of the spot was gray-brown.

The pathogen characteristics identified from symptomatic leaves were fusiform conidia with curved to straight sides. Conidia consisted of five cells which were apical, three median cells, and basal cells. The median cell was uniform in color and had four darker septa than the median cell. Apical cells were hyaline, with 2-3 setae, shaped like threads (flagellum) and hyaline. The basal cell was conical and hyaline, with a pedicel at the bottom of the basal cell (Figure 8B). Based on the description of microscopic characteristics and according to

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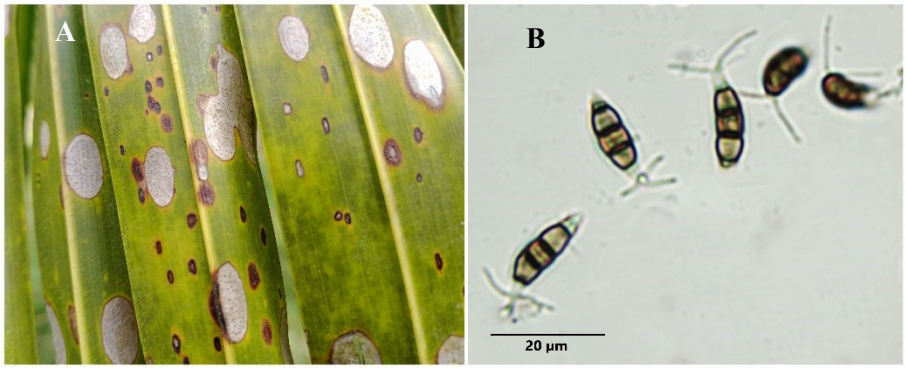

Figure 8. Symptoms of grey leaf spot disease on coconut leaf (A), Conidia of *Pestalotiopsis palmarum* (B).

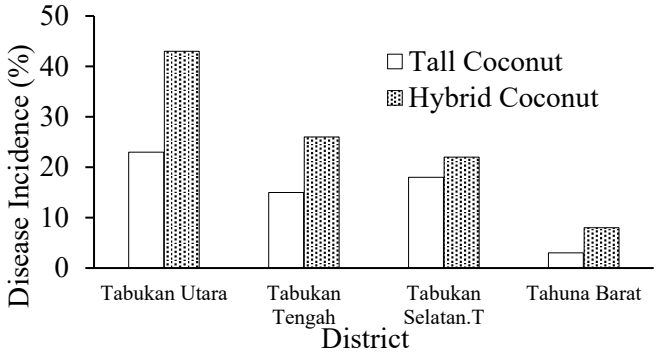

Figure 9. Disease incidence of Tall Coconut and Hybrid Coconut in four districts

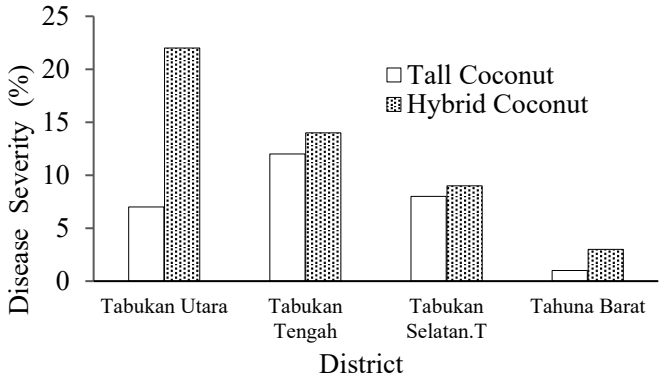

Figure 10. Disease severity of Tall Coconut and Hybrid Coconut in four districts

Oktavianto (2019), the pathogen causing gray leaf spots on coconut in Sangihe Islands is *Pestalotiopsis palmarum.*

The results (Figure 9; Figure 10) showed that disease incidence and severity in Hybrid coconuts plantations were relatively higher than in tall coconuts. It was concluded that Hybrid coconuts are more susceptible to gray leaf spot disease. Furthermore, Mangindaan et al. (1999) reported that Hybrid coconuts were susceptible to several types of diseases in coconuts, such as bud rot and fruit fall. So far, there is no study discussing the resistance of Hybrid coconuts to gray leaf spot disease. Hybrid coconut plantations in Tabukan Utara and Tall coconut plantations in Tabukan Tengah were often submerged by tides. However, the disease severity of submerged Hybrid coconut was higher than tall coconut in the same environmental condition. It suggested that tall coconut was more adaptive to tidal inundation.

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CONCLUSION

Coconut pests in Sangihe Islands Regency were *Sexava coriacea*, *Oryctes rhinoceros* L., *Brontispa longissima*, *Aceria guerreronis*, and white-tailed rats. While gray leaf spot was the only leaf disease found that was caused by the fungus *Pestalotiopsis palmarum*. These pests and diseases were generally in low damage intensity so that they did not become a concern of farmers, despite being important pests and diseases in other regions of Indonesia. The natural agroecosystem factors contributed to this condition. The Tall Coconut species were more adaptive to stress conditions such as leaf spot disease and tidal inundation. To our knowledge, this is the first report about coconut pests and disease information in Sangihe Islands Regency.

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