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RESEARCH PAPER

Potential pests and diseases on *Sari Intan* snake fruit in Bintan Regency, Riau Islands, Indonesia

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ABSTRACT

Sari intan is a superior variety of snake fruit developed in Bintan District, Riau Islands, in 2015. The pests and diseases that attack the *Sari Intan* variety are not yet known. This research was conducted to analyze and identify potential pests and diseases affecting Sari Intan snake fruit at different plant ages in Bintan Regency. A survey was conducted in nurseries and in plantations with two- and five-year-old plant populations. Insects found were collected and identified in the laboratory. Plant parts showing disease symptoms were also collected; the pathogens were identified, and the intensity of damage was measured. Data were processed using Microsoft Office Excel 2010 and described qualitatively. The results showed that potential insect pests included *Iceria* sp. (Hemiptera: Monophlebidae), *Coccotrypes* sp. (Coleoptera: Curculionidae), and *Setothosea asigna* (Lepidoptera: Limacodidae). A non-insect pest observed was *Zonitoides arboreus* (Stylommatophora: Gastrodontidae). The incidence of disease in *Sari Intan* snake fruit leaves reached 100%, with a damage intensity of 58,7%, caused by fungal infections. The fungi identified were *Pestalotia* sp., *Colletotrichum* sp., *Helminthosporium* sp., *Fusarium* sp., and *Curvularia* sp. An important postharvest disease was fruit rot, caused by *Thielaviopsis paradoxa*.

Key words: Fungi, insect, non insect, pest and disease, *Sari Intan*

INTRODUCTION

The snake fruit plant (*Salacca zalacca* Gaertn.) is a fruit species native to Indonesia (Mogea, 1983) and exhibits high genetic diversity, with its distribution spanning almost every province. Snake fruit is considered one of the Indonesia's leading horticultural commodities due to its economic and strategic value. It has a specific advantage over other fruit commodities, if managed well, it can be harvested 2–3 times a year (Hadiati et al., 2008).

Several varieties of snake fruit are widely cultivated and have high commercial value in Indonesia, including, *Pondoh* from Yogyakarta, *Gula Pasir* from Bali, *Padangsidempuan* from North Sumatra, and *Nglumut* from Magelang. In addition, the *Sari Intan* snake fruit from Bintan Regency is a new superior variety developed through collaboration between the Agricultural Research and Development Agency and Bintan Regency, and first introduced in 2015 (Hadiati, 2016).

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The advantages of *Sari Intan* snake fruit include its sweet taste (TSS: 19–21 °Brix), thick flesh (0.3–1.3 cm), non-astringent flavor, fragrant aroma, and long shelf life (10–14 days) (Kementan, 2009). *Sari Intan* snake fruit contains a high level of vitamin C at 27.78 mg, which is greater than the vitamin C content of *Gula Pasir* and *Pondoh* snake fruits, which are 19.48 mg and 10.02 mg, respectively. It also has a total sugar content ranging from 17.75% to 18.35% and a crunchy fruit texture (Fitriani, 2020). Snake fruit is typically consumed fresh and offers many health benefits, providing fiber, minerals, antioxidants, and vitamins to the body (Redaksi AgroMedia, 2009).

Pest and disease attacks can significantly reduce both the quality and quantity of fruit production. According to Puspasari et al. (2020), pests that attack *Madura* snake fruit include mealybugs, scale insects, leaf-mining caterpillars, shield lice, snake fruit weevils, fruit-eating beetles, fruit flies, and termites. Pests commonly attacking sidimpuan snake fruit include shoot-destroying beetles (*Omoteus serrirostois,* Coleoptera: Curculionidae), fruit-destroying beetles (*Omoteus miniatrocnitus,* Coleoptera: Curculionidae), and mealybugs (*Pseudococcus citri,* Hemiptera: Pseudococcidae) (Sariman et al., 1999).

Diseases that frequently attack snake fruit plants include flower rot and fruit rot, especially during the rainy season or when plantation humidity is relatively high. Flower rot is caused by fungi such as *Fusarium oxysporum*, *F. moniliformae, F. decemcellulare*, and *Marasmuis* spp. Fruit rot is caused by *Ceratocystis paradoxa* and *Fusarium* spp. (Cahyono, 2016). According to Sariman et al. (1999), diseases affecting *Sidimpuan* snake fruit include white fungus disease (*Corticium salmonicolor*) and fruit rot disease.

However, information about pests and diseases affecting *Sari Intan* snake fruit in Bintan Regency is currently lacking. Therefore, this research aims to identify pests and diseases in *Sari Intan* snake fruit at different growth stages—nurseries, two years after planting (YAP), and five YAP—in Bintan Regency, Riau Islands, and to analyze the severity of disease incidence.

MATERIALS AND METHODS

Research Site. The research was carried out from June to December 2022 in *Sari Intan* plantation and nurseries in three sub-districts in Bintan Regency: East Bintan Sub-district (0°54’17.6”N, 104°33’59.5”E), Teluk Bintan Sub-district (0°59’14.7”N, 104°30’08.8”8E), and Toapaya Sub-district (0°58’12.2”N, 104°35’03.4”E) (Figure 1). Identification of pests and plant disease pathogens was conducted at the Class II Tanjungpinang Quarantine Center Laboratory (Riau Islands), the Insect Biosystematics Laboratory, and the Plant Mycology Laboratory, Department of Plant Protection, Faculty of Agriculture, IPB University.

Observation of Pest. Pest observations were conducted at three plant age levels: nursery, two years after planting (not yet bearing fruit), and five years after planting (bearing fruit). Insects found in the snake fruit plantations were collected in bottles containing 70% alcohol. Observations were carried out visually by collecting insects directly from the plants. For fruit pests, symptomatic fruits were collected and taken to the laboratory for further examination of pest presence and damage symptoms.

Bee specimens were identified by matching morphological characters using identification keys from LaBonte (2019), Cock et al. (1987), Williams and Watson (1990), the CABI Digital Library (www.cabidigitallibrary.org), and the Discover life website (www.discoverlife.org).

Observation of Plant Disease. Disease observations included symptom identification, calculation of disease incidence and severity, and pathogen identification. Disease incidence was determined based on the presence or absence of symptoms and was calculated using the formula (Sudiono et al., 2017):

$$P = \frac{n}{N} \times 100\%$$

P = Incidence of disease;
n = Number of diseased plants;
N = Total number of plants observed.

Disease severity was assessed using samples from 30 plants selected through probability sampling and calculated using the Townsend-Heuberger formula (Townsend & Heuberger, 1943; Sepulveda & Chavera et al., 2013):

$$DS = \frac{\sum_{i=1}^{6} (n_i \times v_i)}{Z \times N} \times 100\%$$

DS = Disease severity;
n_i = Number of leaves in a specific damage category;
v_i = Scale value for each attack category (Table 1);
i = Category;
Z = The highest damage scale value;
N = Total number of leaves observed.

Diseases in snake fruit were identified by observing symptoms caused by pathogen attacks. Leaves showing symptoms were collected, wrapped in damp newspaper, and placed in a plastic bag. The samples were transported to the laboratory and stored in a cooling chamber until the identification process (Bapu, 2019).

Identification of Plant Disease Pathogens. Fungi were isolated from diseased plant parts using a moist chamber method. Samples were cut into approximately 1 cm pieces, surface-sterilized with KOH, and rinsed with distilled water. The samples were placed on damp filter paper in Petri dishes and incubated for seven days. Fungal structures that grew were then lifted with clear tape, mounted on glass slides, stained with methylene blue, and observed under a Leica IC90 E microscope. Fungal identification was carried out using reference materials by Barnett & Hunter (1998).

Data Analysis. Data were processed using Microsoft Office Excel 2010 and described qualitatively.

RESULTS AND DISCUSSION

Potential Pests on *Sari Intan* Snake Fruit. Insects with the potential to become pests on *Sari Intan* snake fruit belong to three orders: Hemiptera, Coleoptera, and Lepidoptera. These specific species

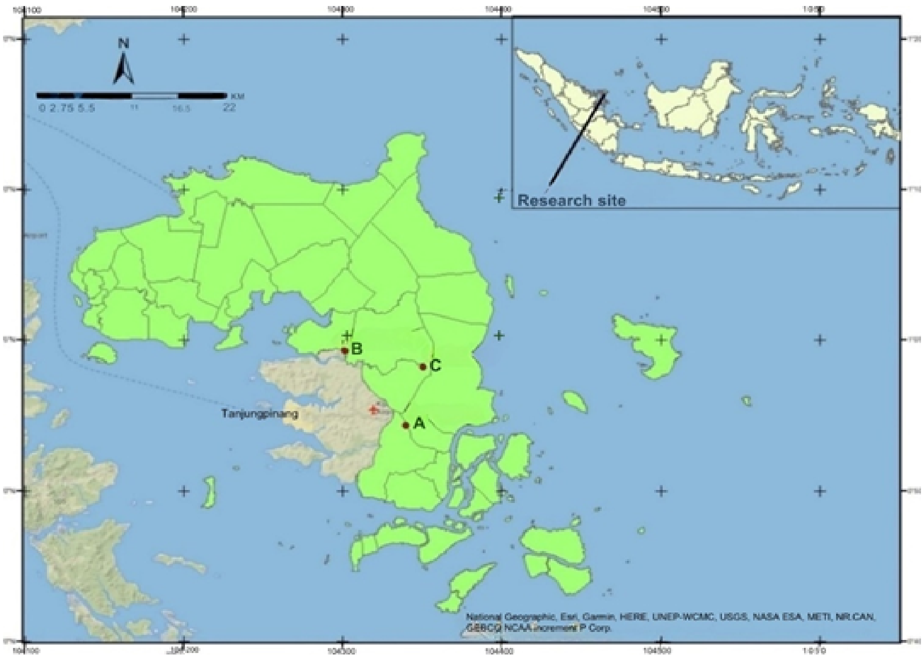

Figure 1. Map of research locations in Bintan Regency. A. UPTD PPDKPP District Bintan; B. BBI Riau Islands Province; C. The farmer's snake fruit garden in Toapaya village, Bintan Regency.

Table 1. Damage category of plant disease attack on plant leaves

Damage category (i)	Scala value (vi)	Percentage of demage (%)	Description
1	0	0	No attack
2	1	$0 < x \leq 10$	Veri low
3	2	$10 < x \leq 25$	Low
4	3	$25 < x \leq 50$	Medium
5	4	$50 < x \leq 75$	High
6	5	$75 < x \leq 100$	Very high

identified as potential pests are *Iceria* sp. (Hemiptera: Monophlebidae), fruit borer *Coccotrypes* sp.) (Coleoptera: Curculionidae), and the fire caterpillar *Setothosea asigna* (Lepidoptera: Limacodidae). *Iceria* sp. was found on both leaves and fruit, *Coccotrypes* sp. on fruit, and *S. asigna* caterpillars on leaves.

Identification of *Iceria* sp. revealed an oval-shaped body with a length of 4.67 mm and nine-segmented antennae measuring 2.39 mm. The limbs are well-developed and of equel size. A submedian pore band is present on the outer edge of the marsupium, along with an internal anal tube, a simple sclerotized ring at the inner tip, and three pairs of abdominal spiracles (Figure 2).

Iceria sp., a member of the Monophlebidae family, typically undergoes1–3 generations per year, depending on climatic conditions. Females develop through four instars, while males go through five. Male prepupae are notably active, with well-developed limbs and antennae (Watson, 2022). Commonly referred to as Steatococcus mites, *Iceria* sp. are invasive pests. If left uncontrolled, infestations can severely impact fruit and horticultural industries as well as endemic fauna on small islands (CABI, 2022). These insects extract large quantities of phloem sap, which dries out plant tissues. Their excretions encourage the growth of sooty mold, which blocks light and air from the leaves, reducing photosynthesis, productivity, and market value (Kondo & Watson, 2022).

Another significant pest is the fruit borer beetle (*Coccotrypes* sp.). Identification showed a stocky body with a head not visible dorsally. The tibia is broad and serrated, with a protibia featuring four serrations. Tarsi consist of five segments, although the fourth segment is very small and often hidden. The procoxae are narrowly separated. The antennae are geniculate, with uneven sutures visible laterally. The lateral edges of the pronotum have carinae extending only partially forward. The anterior margin lacks asperities. The frons is finely striped toward the mandibles. The elytra are convex and not sharply curved at the front, tapering at the tip with small dorsal tubercles and no asperities (Figure 3).

Coccotrypes sp. beetles bore into the fruit and reproduce inside. The primary symptom is a small hole (~1 mm diameter) at the base of the fruit, accompanied by powdery residue. Upon cutting the fruit open, a tunnel is visible leading to the seed, where the beetles reproduce. According to Spennemann (2021), *C. dactyliperda* follows a distinct pattern governed by biomechanical constraints, particularly the beetle's ability to gain traction.

The attack intensity by *Coccotrypes* sp. on *Sari Intan* snake fruit is relatively low, at 13.3%. Control efforts, such as collecting and burning rotten fruit, help reduce the beetle population. Additionally, environmental sanitation and monitoring are regularly conducted by farmers. Taradipha et al. (2019) noted that environmental factors significantly affect insect presence in a habitat.

Fire caterpillars (*S. asigna*), another potential pest, were also identified. These caterpillars have a

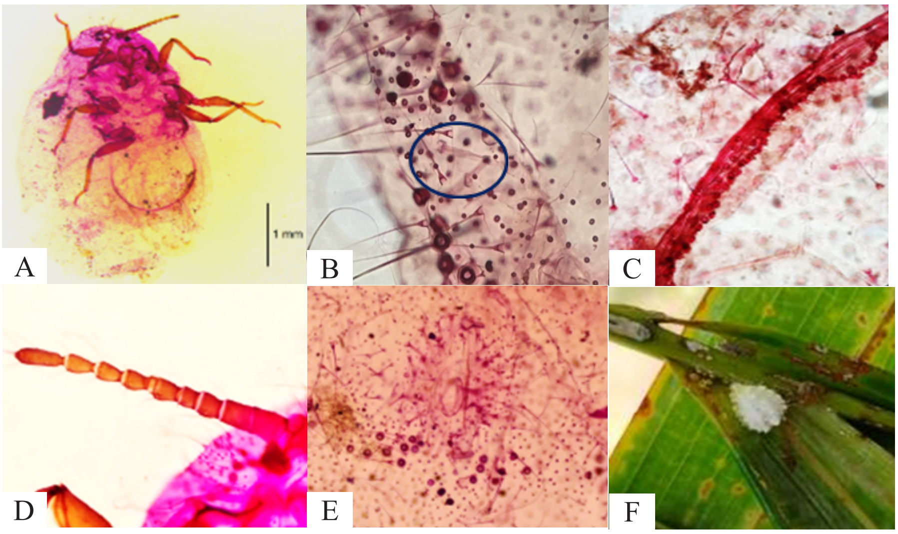

Figure 2. Scale insect *Iceria* sp. A. Oval body; B. Abdominal spiracles; C. Submedian band of pores; D. 9 segment antenna; E. Internal anal tube, inner tip with sclerotized ring; F. *Iceria* sp. stuck under the leaves.

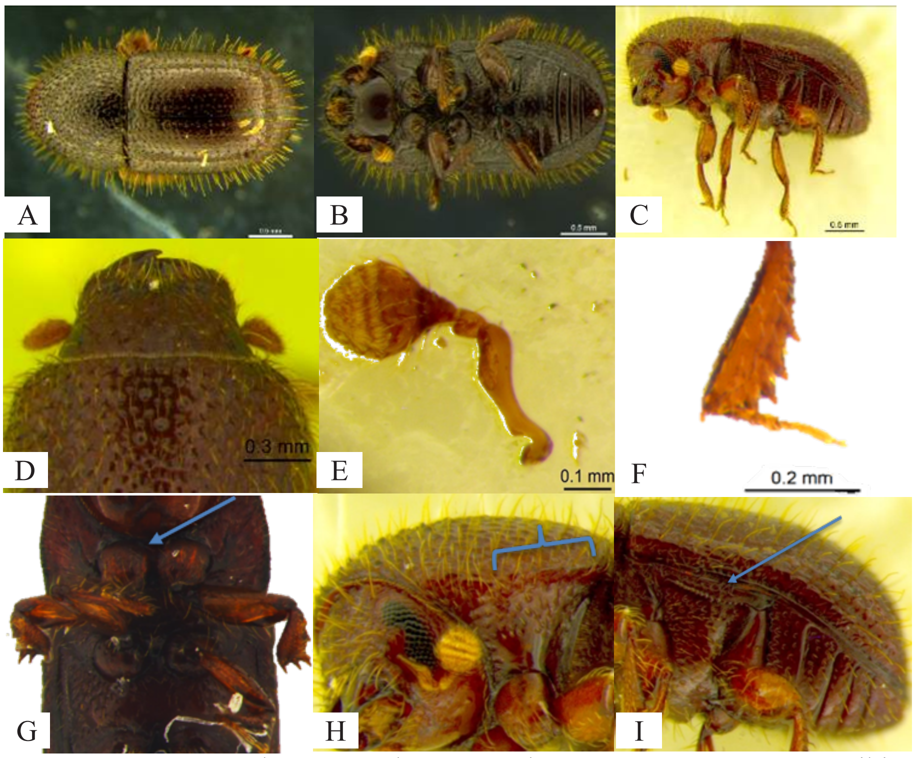

Figure 3. Beetle *Coccotrypes* sp. A. Dorsal; B. Ventral; C. Lateral; D. Frons; E. Antenna; F. Tibia; G. Cnestus; H. Carina pronotum; I. Metepisternum.

green base color, a light brown dorsal stripe, and inner white markings. Their head capsules are hidden, and the anterior side of the prothorax can fold forward. The frontoclypeus is difficult to observe without dissection and contains numerous secondary setae (Figure 4).

S. asigna larvae feed on leaf tissue, disrupting photosynthesis. Nabity et al. (2009) stated that herbivorous insects reduce leaf area and function, ultimately lowering productivity. According to Bambang et al. (2019), leaf damage interferes with photosynthesis, a vital aspect of plant growth.

The damaging stage of *S. asigna* is the larval phase, which lasts around 50 days (Simbolon et al., 2020). While current infestations are relatively mild, the species has the potential to become a serious pest. Rustam et al. (2016) found that 37% of oil palm plants were attacked by S. asigna, resulting in a production loss of 30–40% over 2–3 years (Anggraini & Berutu, 2022).

A non-insect pest found on *Sari Intan* snake fruit was the mollusk *Zonitoides arboreus* (Class Gastropoda, Order Stylommatophora, Family Gastrodontidae). These snails feed on unopened leaves and leave feces on young foliage (Figure 5). *Z. arboreus* has a shiny, transparent shell with a diameter of 4.5 mm.

This species is known as an invasive pest in Hawaii, where it attacks orchid roots (Hollingsworth & Sewake, 2002). In Indonesia, *Z. arboreus* has not been officially reported. According to Ministry of Agriculture Regulation No. 31/Permentan/KR010/7/2018, this species is not listed as a plant pest, possibly due to a lack of awareness or documentation in the region (Mujiono, 2019).

Other Insects on the *Sari Intan* Snake Fruit. Other insects found in *Sari Intan* snake fruit plantations were diverse, belonging to the orders Coleoptera, Lepidoptera, Hemiptera, Orthoptera, Psocoptera, Dermaptera, and Neuroptera. Most insects were found in plantations aged two and five YAP (Table 2). The Coleoptera order was the most frequently encountered in the *Sari Intan* snake fruit plantations.

The presence of insect species in an environment is influenced by various environmental factors, including air temperature, humidity, light intensity, type of vegetation, and food availability (Subekti, 2012). Data from the BMKG Raja Haji Fisabilillah Tanjungpinang Meteorological Station show that in 2022, there were 10 wet months, 1 humid month, and 1 dry month, with an average annual rainfall of 283.75 mm.

The insect population found in the *Sari Intan* snake fruit plantations was relatively low. This aligns with Palumbo (2011), statement that the rainy season negatively impacts insects, as it can cause disease, slow growth rates, and disrupt feeding activities.

Bintan Regency is located on Bintan Island, which has a land area of 1,318.21 km^2 and consists of 272 islands (BPS-Statictics of Bintan Recency, 2022). According to Gillespie & Roderick (2002), the rate of insect immigration decreases with increasing distance from the source (mainland), while extinction rates

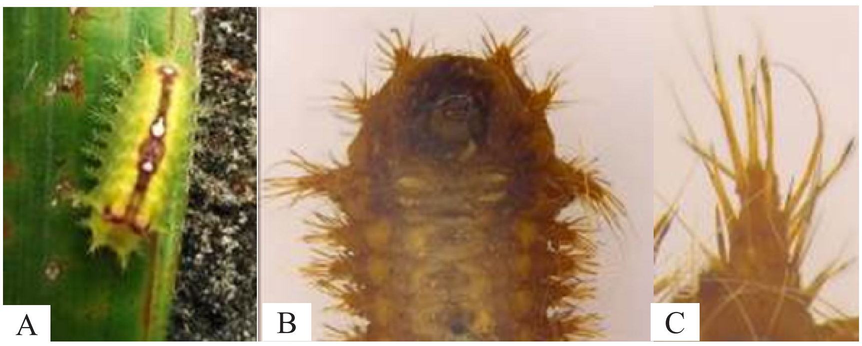

Figure 4. Slug caterpillar. A. Green base color, a light brown dorsal stripe; B. Ventral view; C. Numerous secondary setae and prominent scoli.

Figure 5. *Zonitoides arboreus* and symptoms of infestation. A. Snail body; B. Snail bite marks; C. Snail feces on unopened leaves.

decrease with increasing island size. Bintan Island's remoteness from the mainland influences the presence and diversity of insect species. The number of insects found in the *Sari Intan* plantations was lower than that in *Padangsidempuan* snake fruit plantations. This supports Gillespie & Roderick (2002) conclusion that species richness decreases with island isolation due to reduced immigration rates.

On average, insects found in *Sari Intan* snake fruit plantations are herbivorous, meaning they could damage the snake fruit plants or the surrounding weeds. Most herbivorous insects were found on two-year-old plants. These younger plantations had many weeds and lacked regular maintenance. Different ecosystem conditions can influence the types of insects found in *Sari Intan* plantations. According to Taradipha et al. (2019), the presence of insects in a habitat is a habitat is by environmental characteristics.

Plant Diseases on *Sari Intan* Snake Fruit. Field observations revealed symptoms of fungal infection on *Sari Intan* snake fruit leaves, in the form of light brown to dark brown spots. Initially, the symptoms appeared as small stains and later expanded into irregular shapes (Figure 6). Agrios (2005) states that leaf spots symptoms, which are localized necrotic areas, appear similar across plant species.

Identification of disease symptoms on the leaves revealed that each symptom could be associated with multiple pathogens (Table 3). The pathogens found included *Pestalotia* sp., *Colletotrichum* sp., *Helminthosporium* sp., *Fusarium* sp., and *Curvularia* sp. (Figure 7). Because of this mixed infection, the resulting symptoms were not distinct.

Pestalotia sp. was found across all plant ages. This may be due to the fact that the Sari Intan seeds came from the same source, namely the UPTD. Pathogenic fungi can be seed-borne and spread to new locations.

Colletotrichum sp. was only found in nursery plants and those aged 5 YAP. This may be because 2 YAP plants had less canopy cover, preventing *Colletotrichum* sp. from thriving. This fungus grows optimally at temperatures between 25–30 ºC (Azhari et al., 2019).

Fusarium sp. was found in both nursery and 2 YAP plants. The macroconidia of *Fusarium* sp. are crescent-shaped. The genus *Fusarium* is a soilborne, necrotrophic, and plant-pathogenic fungus that causes serious diseases in many crops worldwide (Agrios,

Table 2. Another insect on sari intan snake fruit

Order/Family	Phase	Part of plant	Crop age (YAP)	Role
Coleoptera				
Nitidulidae	Adults	Fruits	5	Herbivor
Curculionidae	Adults	Leaves	2	Herbivor
Anthribidae	Adults	Leaves	2	Herbivor
Endomychidae	Adults	Leaves	2, 5	Herbivor
Chrysomelidae	Adults	Leaves	2	Herbivor
Lycidae	Adults	Leaves	5	Herbivor
Scarabaeidae	Adults	Leaves	2	Herbivor
Lepidoptera				
Erebidae	Larvae	Leaves	2	Herbivor
Noctuidae	Adults	Leaves	2, 5	Herbivor
Orthoptera				
Tetrigidae	Adults	Leaves	Seedlings	Alga, lichen
Acrididae	Adults	Leaves	2	Herbivor
Psocoptera				
Trichopsocidae	Adults, Nimph	Leaves	Seedlings, 5	Detrivor
Dermaptera				
Anisolabididae	Adults	Leaves	2	Predator
Neuroptera				
Chrysopidae	Adults, Nimph	Leaves	5	Predator

2005).

Post-harvest disease on *Sari Intan* snake fruit was caused by *Thielaviopsis paradoxa* (De Seynes) Hohnel. Symptoms first appeared at the tip of the fruit, which became soft and watery, emitted a sour odor, and showed the presence of white fungal growth. When cut open, the fruit flesh was light brown and soft (Figure 8). The distinctive feature of *T. paradoxa* is the presence of black mycelium on the rotting fruit. According to Jamaludin et al. (2018), this fungus is the primary cause of pointy tip rot in *Pondoh* snake fruit.

Occurrence and Intensity of Disease Damage. Observations of disease incidence and intensity in Sari Intan snake fruit revealed varying levels of severity. Disease incidence on the leaves was high, with almost all plants affected. Disease intensity was categorized as moderate in nursery plants, and severe in 2 YAP and 5 YAP plants. The highest intensity, 58.7%, was recorded in 5 YAP plants (Table 4). Disease severity tends to increase with plant age, likely due to pathogen accumulation over time. According to Triwidodo et al. (2020), disease severity in older plants is often a result of accumulated pathogens from earlier growth stages.

Although the leaf spot pathogen attacks on Sari

Table 3. The type of pathogenic fungus found on the leaves and fruits of *sari intan* snake fruit

Age crop	Found on	Type pathogen
Nursery	Leaves	*Pestalotia* sp.
		Colletotrichum sp.
		Fusarium sp.
2 YAP	Leaves	*Pestalotia* sp.
		Helminthosporium sp.
		Fusarium sp.
		Curvularia sp.
5 YAP	Leaves	*Pestalotia* sp.
		Colletotrichum sp.
	Fruits	*Thielaviopsis paradoxa*

Figure 6. Symptoms of plant disease on *Sari Intan* snake fruit leaves. A. nursery; B. 2 YAP; C. 5 YAP.

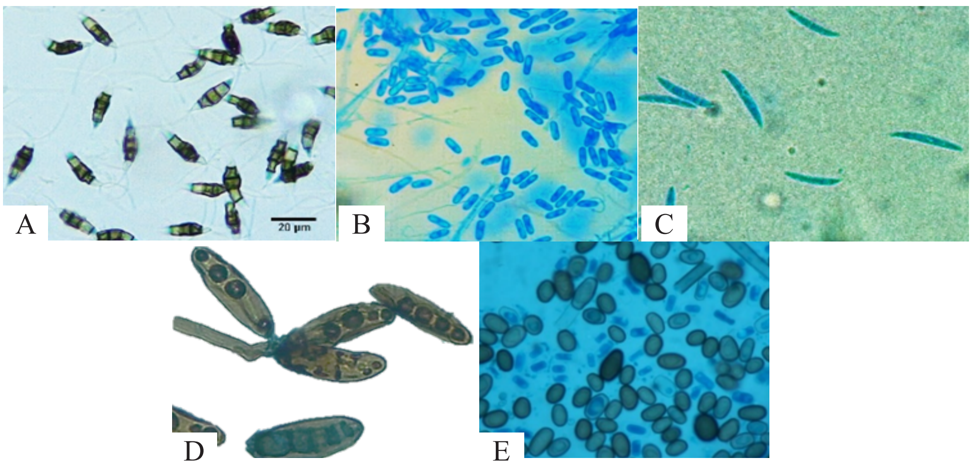

Figure 7. Fungal conidia found on the leaves, A. *Pestalotia* sp.; B. *Collethotrichum* sp.; C. *Fusarium* sp.; D. *Helminthosporium* sp., D. *Curvularia* sp.

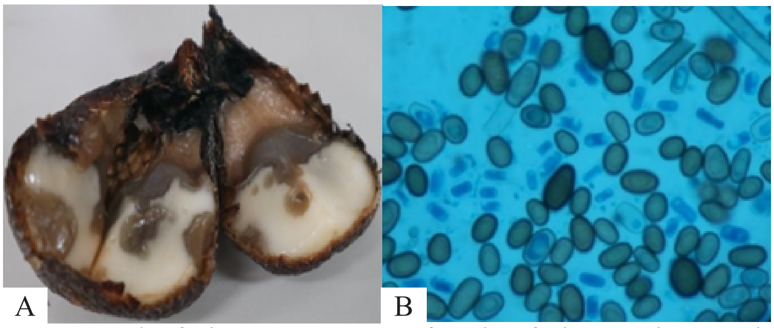

Figure 8. Fruit rot on *sari intan* snake fruit. A. Symptoms of rotting fruit; B. Microscopic spores of *T. paradoxa* the cause of fruit rot.

Table 4. Incidence and severity of leaf disease infestation on *sari intan* snake fruit

Crop Age	Incidence (%)	Severity (%)	Description
Nursery	91	19,6	Medium
2 YAP	100	29	High
5 YAP	100	58,7	High

Intan snake fruit were relatively severe, their impact was not yet significant. However, if left unmanaged, the disease could continue to develop and threaten the plants, especially during the seedling phase. Seedlings, as the future field-planted crops, are vulnerable to rapid disease progression under conducive environmental conditions, increasing the risk of disease becoming endemic. Furthermore, seedlings are more susceptible to pathogen attacks (Anggraeni & Dendang, 2009).

CONCLUSION

Insects that have the potential to become pests on *Sari Intan* snake fruit include *Iceria* sp., *Coccotrypes* sp. (fruit borer beetle), and *Spodoptera asigna* (fire caterpillar). In addition to insects, the mollusk *Zonitoides arboreus* was also identified as a pest of *Sari Intan* snake fruit. Pathogenic fungi found on the leaves of *Sari Intan* snake fruit were *Pestalotia* sp., *Colletotrichum* sp., *Helminthosporium* sp., *Fusarium* sp., and *Curvularia* sp., all of which caused similar symptoms. The fungus responsible for post-harvest fruit rot was *Thielaviopsis paradoxa.*

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AUTHORS’ CONTRIBUTIONS

MF, NM, and ETT conceptualized and planned the experiment. MF conducted observations of pests and diseases affecting Sari Intan snake fruit. MF and NM identified the insect species found. MF and ETT identified the pathogens present on the leaves and fruit. MF collected data on plant damage caused by pathogens. I performed the data analysis and interpreted the results. I also prepared the manuscript. All authors contributed to discussions on the research flow, data analysis, and manuscript structure. All authors have read and approved the final manuscript.

COMPETING INTEREST

The authors declare no competing interests.

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