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Identification pests and diseases of coffee plant on Mount Puntang as a basis for integrated pest management to support sustainable development goals

Ihda Siti Luthfia[1*], Yusuf Ibrahim[1], Adi Rahmat[2]
[1]Department of Biology Education, Universitas Pasundan, Jl. Tamansari no. 6-8, Bandung City, West Java, Indonesia
[2]Department of Biology Education, Universitas Pendidikan Indonesia, Jl. Dr. Setiabudi No. 229, Bandung City, West Java Indonesia
[*]Corresponding author: ihdasiti0601@gmail.com

ABSTRACT

One of the main advantages in plantation exports in Indonesia is coffee plants, but it should be known that there are many types of pests associated with coffee planting. identifying pests and diseases is the basis for reducing possible crop losses. This research aims to control the growth of pest populations. This research uses a descriptive approach by directly following up in the field by making direct observations in sampling the data to be obtained. Performed by identifying the types of pests and diseases found in coffee plants in Gunung Puntang Bandung by making Belt Transect and performing 2 sampling techniques: hand sorting and beating tray. The overall pest species that were sampled in 3 sampling times in the Gunung Puntang Bandung coffee plantation consisted of 6 orders, and 27 pest species that attacked coffee plants. There are 5 types of damage caused by pests found in Gunung Puntang Coffee Plantation, namely leaf miner perforated leaves by Spodoptera litura and chrysomelidae, fruit rot and Green Coffee Scale Disease. There are five diseases identified, namely Cercospora leaf spot rust, Powdery mildew, Antarnoxa, and Coffee Berry Desease. The thing that affects the number of pests and diseases in Gunung Puntang coffee plantations is the climate and environmental conditions that are adequate for these pests to develop and grow.

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INTRODUCTION

One of the main advantages in the export of plantation crops in Indonesia is coffee. Coffee can be processed into a beverage with a distinctive flavor, marked by the increasing number of people who enjoy it, both among the elderly and the youth. In fact, many young people now consider drinking coffee to be a trend in their lives (Irawan, 2023) .

Indonesia has developed three consecutive coffee varieties based on their production levels: Robusta, Arabica, and Liberica. The superiority of a coffee variety can be seen in its high production levels and the flavor of the coffee it produces. However, the yield and quality of coffee plants depend on climate, altitude, coffee species cultivated, cultivation methods, post-harvest processing, and post-harvest handling (Ayalew et al., 2024). Therefore, Arabica coffee thrives better in highland

areas, while Robusta coffee is more suitable for lowland areas. The type of coffee plant in the Gunung Puntang Bandung plantation is Arabica Linies.

Coffee is one of the plantation commodities with significant economic value compared to other crops. Besides being a major contributor to the country's foreign exchange earnings, coffee also serves as a source of income for over one and a half million coffee farmers in Indonesia (Indriati et al., 2017).

Gunung Puntang is characterized by high biodiversity, encompassing coffee plants and various supporting organisms such as insects and microorganisms. Research conducted there can assist in identifying various pests and diseases that may pose threats to coffee plants. coffee is a crucial commodity in Indonesia and globally, making it essential to monitor and control pests and diseases that affect coffee production and quality. Coffee plants are known for their long lifespan, as they can create a stable and consistent environment without significant changes from one season to another. It should be noted that there are many types of pests associated with coffee cultivation (Rosniar et al., 2019). Plants affected by pests can experience a decrease in effectiveness or even lose the ability to perform normal metabolic processes (physiology), leading to unhealthy growth or even plant death..(Viccy Leonardo, 2020).

Arabica coffee is more susceptible to pest attacks and diseases compared to Robusta varieties. Although coffee pests are generally small insects, their impact can cause significant damage to coffee plants (Sugiarti, 2019). Therefore, managing pests and diseases in coffee cultivation remains a major concern as it can lead to reduced productivity and lower quality coffee. Pests are organisms that repeatedly and over a long time consistently attack an area with severe levels of infestation. This necessitates efforts in prevention and pest control, applying the Integrated Pest Management (IPM) concept. Such pest attacks can cause damage to the quality of coffee plants (Ayalew et al., 2022).

Abundant research on coffee plant pests and diseases Specifically is research conducted by (Sugiarti, 2019) has revealed diverse pests and microorganisms linked to these plants. This research expands on prior work by investigating the potential of IPM approaches to tackle SDGs. Coffee farmers will find the study's findings valuable as they offer guidance on effective pest and disease management strategies for coffee plantations. Integrated Pest Management (IPM) strategies can support and contribute to achieving Sustainable Development Goals (SDGs). It focuses on enhancing coffee production (SDG 15), which aims to manage terrestrial ecosystems sustainably, combat land degradation, stop land conversion into deserts, and halt biodiversity loss (Rada et al., 2021). Conservation of biodiversity, as targeted in SDG 15 to protect, restore, and sustainably use terrestrial and marine ecosystems, manage forests sustainably, and halt biodiversity loss, can aid in natural pest and disease control (Morton et al., 2017). High biodiversity helps maintain ecosystem balance and suppress pest and disease populations. Sustainable coffee production not only supports food security and farmer welfare but also protects natural ecosystems, all contributing to holistic sustainable development goals (United Nations, 2017).

METHOD

This research employs a descriptive method by directly observing and sampling the data of interest. The study focuses on identifying the types of pests and diseases found in coffee plants at

Gunung Puntang Bandung. The research design utilizes Belt Transect methodology, where a measuring tape is laid across the vegetation to achieve the desired transect length. Belt transects are long, narrow strips of land laid out in the Gunung Puntang research area to study pests, fungi, and microorganisms. The width and length of these transects are predetermined, and they serve as observation trails for researchers to document the types and numbers of organisms present (Grant et al., 2004). The research involves identifying coffee plant pests and observing coffee plants, particularly their leaves, stems, and fruits, to visually assess the presence of pests. Sampling techniques include hand sorting and the use of a beating tray. The study is conducted in the coffee plantations at Gunung Puntang Bandung, covering an area of 700x100 meters, divided into 8 plots, each measuring 30x30 meters.

RESULTS AND DISCUSSION

The research findings obtained from the sampling at Gunung Puntang coffee plantation yielded results in the form of pests and diseases affecting coffee plants.

Table 1. Species of pests of coffee plants

Species of pests	Total
Epilachna admirabilis	6
Lilioceris lilii	13
Brachypnoea cretifera	46
Hybosorus iligeri	15
Poecilus cupreus	12
Phyllobius pyri	24
Ernobius mollis	23
Phyllobius glaucus	7
Chilocorus	76
Goeldichironomus	7
Hermetia illucens	15
Bactrocera doralis	122
Oxya chinensis	6
Philaenus spumarius	26
Sanurus indecora	12
Aphis gossypii	208
Coccus hesperidum	28
Coccus viridis	181
Aphis fabae	26
Megaphasma dentictus	2
Ctenomorpha marginipennis	2
Hyposidra talaca	48
Lymantria dispar	4
Spodoptera litura	46
Hyles lineata	5
Dasychira meridionalis	2
Malacosoma americanum	6

Overall, the insect species sampled three times at Gunung Puntang coffee plantation in Bandung consisted of 6 orders and 27 species, totaling 968 individuals attacking coffee plants. The sampled insect species can be seen in (Table 1). The most prevalent species at Gunung Puntang coffee plantation is Aphis gossypii, belonging to the family *Aphididae*, with 206 individuals. According to Greek, *Aphididae* means "fluid-sucking." *Aphis gossypii* prefers warm and humid climates, such as those found at Gunung Puntang. This pest is commonly found at lower altitudes, such as the foothills of Gunung Puntang. It thrives in high humidity, characteristic of Gunung Puntang's climate. This behavioral pattern indicates that the insect has specific habits, primarily feeding on plant fluids as its food source (Rismayani et al., 2020). This explains why *Aphis gossypii* is the most commonly found pest at Gunung Puntang coffee plantation.

In addition to food sources, the behavior and development of insects are also influenced by interactions with the environment, especially climate or weather factors such as temperature, rainfall, humidity, and others. Some insects, for example, are significantly influenced by temperature, which affects various aspects such as food consumption, developmental rates, geographic distribution, population size, outbreaks and migrations, larval emergence timing, and the number of generations that can develop in a single season. The impact of climate can be direct, affecting insect activity levels, or indirect, influencing the development of pests and diseases by affecting the environmental conditions in which insects live. Climate parameters also play a crucial role in regulating insect life cycles and their lifespan (Susanti, 2019).

Table 2. Damage on Coffee Plants

Damage	Causes	Symptoms	Total infection (%)
Leaf Miner	*Leucoptera*	Irregular brown spots or patches on the upper leaf surface.	15%
Perforated leaves *(Spodoptera)*	*Spodoptera litura*	Bite marks that make the leaves appear perforated and damaged	8%
Perforated leaves *(Chrysomelidae)*	*Chrysomelidae*	Small holes and yellowing of leaves.	10%
Fruit Rot	*Hypothenemus hampei*	Presence of fecal residue around entry holes.	3%
Green Coffee Scale Disease	*Coccus Viridis*	Numerous Coccus Viridis pests adhering to coffee fruits	11%

The damage caused by pests includes 5 types found in Gunung Puntang Coffee Plantation, namely leaf miner caused by Leucoptera. Leaf miner disease attacks the leaves of coffee plants due to *Leucoptera coffeella* infestation, also known as leaf miner pests. These insects typically appear in dense coffee plantation areas and consume palisade parenchyma tissue within the leaves (Wahyuningtyas et al., 2022). This reduces the leaves' ability to photosynthesize, leading to decreased coffee plant productivity as many leaves fall and die due to these attacks, affecting 15% of the plants. Holes in leaves caused by *Spodoptera litura* show significant leaf damage from this pest, with perforations visible on all sides. Meanwhile, leaf damage caused by *Chrysomelidae* results in smaller

holes on the leaves. Fruit rot caused by Hypothenemus hampei and Green Coffee Scale Disease caused by *Coccus viridis* also affect coffee production in Gunung Puntang. If left untreated, these damages can spread throughout the coffee plants. The damage to coffee plants is evident from the symptoms observed on the leaves and fruits, primarily caused by insects.

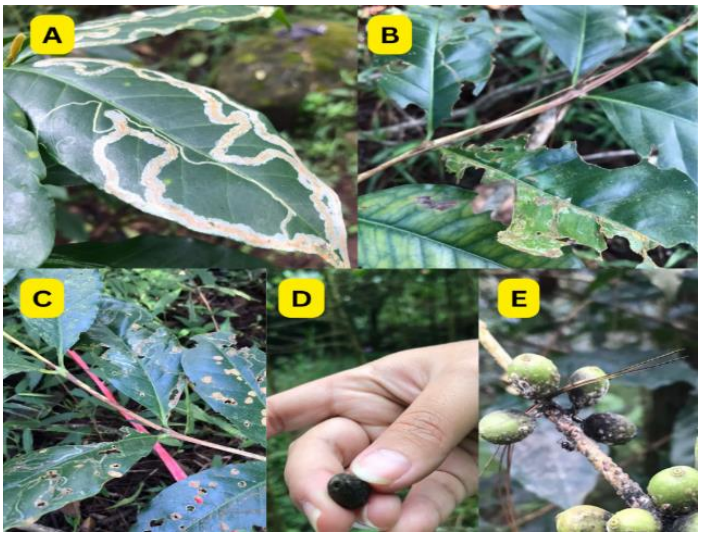

Figure 1. Damage due to pests of Coffee Plants A) Leaf Miner, B) Perforated leaves (Spodoptera), C) Perforated Leaves (Chrysomelidae), D) fruit rot, E) Green Coffee Scale Disease.

Based on research, it is known that controlling pests and diseases in coffee plants is crucial to improving harvest yields and coffee quality. Pest and disease control can be achieved through various methods, including natural enemies control, mechanical control, and biological control. Integrated Pest Management (IPM) is an effective and sustainable method for controlling pests and diseases in coffee plants. Utilizing natural enemies such as parasitoids, predators, and pathogens is also essential. If insecticides must be used, herbal insecticides should be considered before synthetic ones. The pests found in the coffee plantations at Mount Puntang are insects classified into 4 groups based on their mouthparts structure.

Based on the classification of pests according to their mouthparts structure, it is observed that species with chewing mouthparts belong to the orders *Coleoptera, Phasmatodea,* and *Orthoptera.* Species with sponging mouthparts include Bactrocera doralis and Hermetia illucens. Species with piercing-sucking mouthparts include Aphis fabae, Coccus viridis, Coccus hesperidum, Philaenus spumarius, Sanurus indecora, and *Aphis gossypii*. *Lepidoptera* order species have siphoning-chewing mouthparts (Boyle, 2021) This classification of pests helps to determine the type of damage caused by each pest according to its mouthparts structure.

Insects with chewing and siphoning mouthparts are among the main pests that attack various plants, especially coffee plants. According to interviews with local farmers, these insects are particularly concerning for them, prompting the farmers to urgently seek accurate pest control predictions. Controlling pests with chewing mouthparts can be achieved by integrating various sustainable pest control methods to achieve optimal results. One necessary action is to balance n atural enemies of these orders, similar to the findings in the research by (K. Bagus, N. Luh, 2016). The most effective control method to eradicate *Coleoptera* pests is by balancing natural enemies. Additionally,

precise control involves cultural measures such as monitoring plants showing symptoms and removing branches or stems infected by beetles (Chapman, 2012). Infected branches should be pruned and destroyed. While some orders act as natural enemies, it cannot be denied that beetles themselves contribute to leaf damage and are considered pests. In dealing with pests with sponging mouthparts, the control process requires several traps because controlling these pests is considered difficult. Therefore, traps are necessary to effectively control pests with sponging mouthparts.

For pests with piercing-sucking mouthparts, the appropriate control method is biological control or utilizing natural enemies. Effective biological control of insects with piercing-sucking mouthparts requires maintaining locally effective natural enemies, often through environmental manipulation techniques. Environmental manipulation aims to enhance the role of natural enemies by providing alternative hosts or prey, offering nectar sources, or altering crop cultivation techniques. This includes avoiding activities detrimental to natural enemies, such as broad-spectrum insecticide use. If other control methods are used, they should synergize with the exploitation of natural enemies. Implementing multiple synergistic control methods constitutes Integrated Pest Management (IPM), aimed at reducing economically damaging pest populations.

Table 3. Diseases in Coffee Plants

Disease	**Causes**	**Symptoms**	**Total infection (%)**
Leaf Rust	*Hemileia vastatrix*	Presence of orange, powdery spores	30%
Leaf Spot *Cercospora*	*Cercospora. coffeicola*	Round brown spots on leaves, dark brown in color	10%
Powdery mildew	*Erysiphae diffusa*	Coffee leaves covered with fine white and grayish layer	4%
Anthracnose	*Colletotrichum spp*	Brown spots on leaves with small black spots	2%
Coffe Berry Desease	*Colletotrichum kahawae*	Dark brown to blackish, slightly sunken spots on coffee berries	5%

Based on the disease data observed at Gunung Puntang Plantation in (Table 3), it is evident that there are 5 types of diseases affecting coffee plants: Leaf Rust, Leaf Spot (Cercospora), Powdery Mildew, Anthracnose, and Coffee Berry Disease as depicted in (Figure 2). The data in (Table 3) shows that the most prevalent disease affecting coffee plants at Gunung Puntang is Leaf Rust. Leaf Rust disease can proliferate dramatically depending on environmental conditions such as high rainfall, humidity, and temperature, making the plants more susceptible. These diseases have a significant negative impact on coffee production potential at Gunung Puntang.

Leaf Rust is a plant disease caused by the fungus *Hemileia vastatrix*. Plants heavily affected by this fungus experience a decline in leaf health, leading to leaf drop and decreased fruit production, resulting in losses for farmers at Gunung Puntang. The visible symptoms of coffee leaf rust include leaves with yellow spots and the presence of H. vastatrix fungus spores, resembling orange-colored powder known as uredospores (E.K. Kathurima, G. Aluora, 2017). Biological control methods can be

employed to manage Leaf Rust, including the use of resistant coffee varieties and beneficial microbes such as Bacillus thuringiensis and Verticillium hemileia, as suggested by (Defitri, 2016).

Figure 2. Diseases in Coffee Plants A) Leaf Rust, B) Leaf Spot (Cercospora), C) Powdery Mildew, D) Anthracnose, E) Coffee Berry Disease

Cercospora coffeicola fungus causes Leaf Spot disease on coffee plants. Symptoms include yellow spots surrounded by circles on coffee leaves, irregular in size and scattered randomly. Weather conditions at Gunung Puntang greatly influence the development of *Cercospora* due to its preference for highly humid environments. Leaf spot disease caused by *Cercospora* still requires continuous monitoring because coffee plants are highly susceptible to this disease, despite the limited identification of the disease in this research. Control measures are necessary as leaf spot disease spreads through spores carried by wind, rainwater, and even insects. Effective control to reduce disease spread includes biological methods aimed at slowing down its progression. Similar to research findings, using botanical fungicides also offers advantages by avoiding environmental pollution.

Powdery Mildew, caused by the fungus *Erysiphae diffusa*, affects 7 identified coffee plants at Gunung Puntang. Symptoms include white spots on leaves resembling powder, which consist of conidia and conidiophores, according to (Sumartini & Rahayu, 2017) Factors such as temperature, humidity, and sunlight influence this disease, with plots exposed to more sunlight being more susceptible. Anthracnose disease caused by the fungus Colletotrichum sp. The symptoms visible on affected plants include yellow spots and slight curling of the leaves (Rizki Abi Amrullah et al., 2023). Control measures for this disease are still limited, so the appropriate approach is to focus on maintaining the health of coffee plants, pruning infected parts to prevent the disease from spreading to other coffee plants. Anthracnose disease, caused by the fungus Colletotrichum sp., manifests initially with the formation of brownish-black spots on the plant, which later develop into soft rot. Within these spots, there are black dots consisting of fungal structures called setae and conidia.

Coffee Berry Disease (CBD) affects coffee berries at Gunung Puntang during their development stage, leading to decreased yields. Symptoms include discoloration, reduced yields, and rotting of

berries and seeds. This disease is more prevalent during rainy seasons in regions with high humidity and wet climates. Research by (Ayalew et al., 2024). Indicates that CBD and Arabica coffee are highly sensitive to minimum and maximum temperatures. Effective control methods may involve the use of *Streptomyces spp*., a gram-positive bacterium from *Actinomyces*, known to produce clinically important antimicrobial compounds (Pacios-Michelena et al., 2021). This aligns with research suggesting Streptomyces spp. as effective biocontrol agents against pathogenic fungi by breaking down chitin cell walls and inhibiting their growth (LaksamananAgadhia Raharjo, 2021). Thus, Streptomyces spp. could be effectively utilized to control Anthracnose and Coffee Berry Disease.

CONCLUSION

The pest species identified in the sampling at Gunung Puntang Coffee Plantation in Bandung consist of 6 orders and 27 species that attack coffee plants. The species most prevalent in attacking coffee plants is Aphis gossypii. Damage caused by pests includes 5 types found at Gunung Puntang Coffee Plantation: leaf miner, holes in leaves caused by Spodoptera litura and chrysomelidae, fruit rot, and Green Coffee Scale Disease. Five diseases have been identified: leaf rust, leaf spot (Cercospora), powdery mildew, anthracnose, and Coffee Berry Disease. Factors influencing the abundance of pests and diseases at Gunung Puntang Coffee Plantation include climate and environmental conditions conducive to the development of pests, allowing them to find food sources by damaging plants. Therefore, achieving a balance with natural enemies of these pests is crucial for control, aligning with Sustainable Development Goal No. 15 "Life on Land," which aims to take action to control pests and protect biodiversity, forests, and other terrestrial ecosystems. Given the diversity of pests found, it is recommended for future research to use or develop more comprehensive sampling methods.

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