



The Influence of Monoculture and Polyculture Planting Patterns on the Intensity of Pest Attacks by *Helopeltis* sp. on Arabica Coffee of the Sigarar Utang Variety in North Tapanuli Regency

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Received: October 31, 2023

Revised: November 29, 2023

Accepted: December 20, 2023

Published: December 31, 2023

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DOI: [10.29303/jppipa.v9i12.5924](https://doi.org/10.29303/jppipa.v9i12.5924)

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Abstract: Coffee is one of the leading commodities in the plantation subsector in North Sumatra which has good market opportunities both domestically and abroad. Especially in the Lake Toba area, apart from the PBKo pest, it turns out that attacks by the coffee leaf sucking pest *Helopeltis* sp. are also felt to be very important by farmers, because the presence of *Helopeltis* sp. This causes the coffee leaf shoots to develop brown spots, curl and eventually dry out and die (die back). The aim of the research was to study the symptoms of attacks and the intensity of *Helopeltis* sp. attacks on Arabica coffee plants in the Lake Toba area, North Tapanuli Regency. This research was carried out on people's coffee plantations in North Tapanuli Regency at an altitude of 1,300 meters above sea level, from February to June 2023. On the Sigarar Utang variety Arabica coffee plantation with monoculture and polyculture planting patterns. The sample plants were determined to be 10% of the total plants at each observation location. Sampling of plant samples is determined using a zig zag line. The parameters observed were the intensity of attacks and the percentage of pest attacks. The results obtained by *Helopeltis* sp. sucking shoot pests have been known to attack coffee plants in North Tapanuli Regency with symptoms of attack. At the start of the attack, leaf spots are visible, brown, curly and eventually dry out, die back, then grow rosettes, namely shoots, new ones that are shortened tightly and do not develop. The intensity of attacks by *Helopeltis* sp. on smallholder coffee plantations in North Tapanuli Regency is quite varied, from light to heavy attacks with the intensity of shoot attacks ranging from 15.67% to 57.80%. Monoculture coffee plantations with protective plants, but no pruning, are locations with *Helopeltis* sp. attack levels in the heavy category with shoot attack intensity reaching 56.66%. The intercropping coffee plant cultivation system (polyculture) had a significant influence on the low intensity of *Helopeltis* sp. attacks, where $t_{count} (8.921) > t_{table} (2.306)$.

Keywords: Arabica Coffee; *Helopeltis* sp.; Monoculture; Planting Patterns; Polyculture

Introduction

Coffee is one of the leading commodities in the plantation subsector in North Sumatra which has good market opportunities both domestically and abroad. Data from the International Coffee Organization, Indonesia is ranked 4th as the largest coffee exporting country in the world after Brazil, Vietnam and

Colombia. BPS (2021) data shows that coffee exports increased by 7.5% from 335.76 thousand tons in 2019 to 384.51 thousand tons in 2021. The area of coffee plantations in the Lake Toba area is currently continuing to increase, of which 96% is dominated by smallholder plantations, with production of 810 kg/ha/year which is still low compared to Arabica coffee productivity which should be able to reach 2000 kg/ha/year. Efforts

How to Cite:

Kuswardani, R. A., Mardiana, S., Suswati, & Sihotang, S. (2023). The Influence of Monoculture and Polyculture Planting Patterns on the Intensity of Pest Attacks by *Helopeltis* sp. on Arabica Coffee of the Sigarar Utang Variety in North Tapanuli Regency. *Jurnal Penelitian Pendidikan IPA*, 9(12), 11296-11301. <https://doi.org/10.29303/jppipa.v9i12.5924>

to increase Coffee productivity and quality must continue to be improved so that the competitiveness of coffee in Indonesia can compete in the world market. In the management of people's coffee plantations, many problems are found, including the lack of implementation of Good Coffee Cultivation (Good Agriculture Practices/GAP) in accordance with the Regulation of the Minister of Agriculture of the Republic of Indonesia Number 49 of 2014. Attacks by the coffee berry borer (*Stephanoderes hampei*) and leaf rust in coffee plantations can reduce production up to 50% (Dufour et al., 2021).

Especially in the Lake Toba area, apart from the PBKo pest, it turns out that attacks by the coffee leaf sucking pest *Helopeltis* sp. are also felt to be very important by farmers, because the presence of *Helopeltis* sp. This causes the coffee leaf shoots to develop brown spots, curl and eventually dry out and die (die back). *Helopeltis* sp. belongs to the Myridae family, young insects (nymphs) and imago attack plant shoots by piercing their mouthparts into the tissue and then sucking the fluid therein. At the same time as the puncture, the ladybug releases a poisonous liquid which can kill the plant tissue around the puncture. Saliva in *Helopeltis* sp. contains the enzymes amylase, esterase, lipase and maltase (des Gachons & Breslin, 2016). *H. Theivora* has hydrolytic and oxidoreductase enzymes in the salivary glands and in the midgut. Both types of enzymes are related to extra-oral digestion and defense. This causes tissue necrosis and phytotoxicity in the leaves. Sarker et al. (2006) added that oxidoreductase enzymes (catalase, peroxidase, and polyphenol-oxidase) can cause phytotoxaemia. The catalase enzyme can prevent quinone formation, peroxidase can degrade chlorophyll.

Helopeltis sp. is a polyphagous pest, in Indonesia it is known to attack several types of plants, including tea, cocoa, quinine, kapok, cinnamon, castor oil, cashew, avocado, sweet potato, guava and Tephrosia (Indriati, 2014). In the world, 18 types of *Helopeltis* sp. have been found, of which 9 types have been found in Indonesia attacking tea plantations. In Indonesia, *H. antonii* has been reported as the most common leaf-sucking ladybug found attacking tea plantations. Yield losses due to attacks by this pest reach 11-100% (Indriati, 2014). So far there have been no reports of this pest attacking coffee plants. There is no information about *Helopeltis* sp. pests on coffee plants, therefore this initial research is aimed at studying the symptoms of attacks and the intensity of *Helopeltis* sp. attacks on Arabica coffee plants in the Lake Toba area, North Tapanuli Regency.

Method

This research was carried out on people's coffee plantations in North Tapanuli Regency at an altitude of 1,300 meters above sea level, from February to June 2023. On the Sigarar Utang variety Arabica coffee plantation with monoculture and polyculture planting patterns. The sample plants were determined to be 10% of the total plants at each observation location. Sampling of plant samples is determined using a zig zag line. On the selected sample plants, observations were made on the number of shoots, shoots that were attacked by *Helopeltis* sp. and healthy shoots.

Attack Intensity and Attack Percentage

Observations were made on the symptoms of attacks on coffee plant shoots, categories of damage levels and the percentage of shoots attacked by *Helopeltis* sp. The damage caused is calculated based on a severity score and expressed in terms of attack intensity. Meanwhile, the number of infected plant shoots is calculated based on the symptoms of the attack and expressed as a percentage of attacks.

$$\text{Attack Intensity} = \frac{\sum xn}{XN} \times 100\% \quad (1)$$

Description:

x = Score of infected plants (0, 1, 2, 3, 4)

n = Number of plants with score x

X = The highest score of infected plants

N = Number of plants under observation

Score of infected plants:

0 = Healthy plants

1 = Plant shoots are attacked 1-25%

2 = Plant shoots are attacked 26-50%

3 = Plant shoots are attacked 51-75%

4 = Plant shoots are attacked 76-100%

$$\text{Attack percentage} = \frac{\sum n}{N} \times 100\% \quad (2)$$

Description:

n = Number of plants affected

N = Number of plants under observation

Result and Discussion

Attack Symptoms

Helopeltis sp., both nymph and imago stages, attack the shoots of coffee plants by pricking and sucking the leaf fluid (Wijaya et al., 2017; Jaya et al., 2013). When it pricks and sucks the juices from the leaves, the ladybug simultaneously releases its poisonous saliva, causing damage around the plant tissue it pricks, then tissue necrosis and phytotoxicity occurs in the

leaves. At the initial attack, leaf spots appear brown, curly and eventually dry out and die (die back). Some

symptoms of damage caused by *H. antonii* attacks on coffee shoots and buds can be seen in Figure 1.



Symptoms of coffee shoot necrosis

Leaf tips curl and dry

Shoots form rosettes

Figure 1. Symptoms of *Helopeltis* sp. attack on coffee plant shoots

Intensity and Percentage of Attacks in Various Coffee Plant Cultivation Systems

The results of the research from identifying the characteristics of coffee cultivation systems show that there are four types of farming systems used by farmers in cultivating Arabica coffee of the Sigarar Deb specialty variety in the Lake Toba area in North Sumatra, namely monoculture coffee without protection (sun-coffee), intercropping without protection (intercropping sun-coffe), monoculture coffee with protection (simple shade coffee), and multistrata (multistrata shade coffee). Simple shade coffee is a monoculture coffee farming system with shade trees; while the multistrata system is where coffee is planted under protective trees and mixed with several other plants that provide results such as fruit, vegetables, nuts and medicinal plants (Figure 2.), this is in accordance with what was reported by Adams et al. (2007).

plantations in North Tapanuli Regency varied quite widely, ranging from 15.67% to 57.80% (Figure 3).

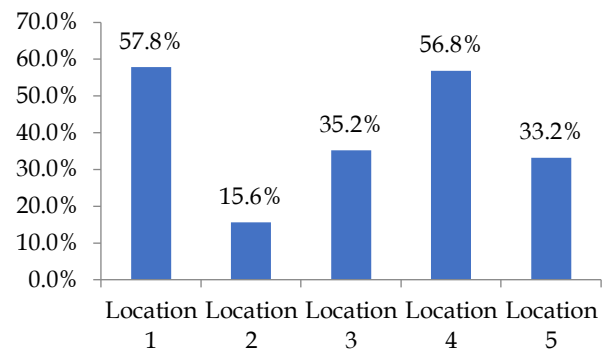


Figure 3. Intensity of *Helopeltis* sp. attacks in various people's coffee cultivation systems in the Lake Toba area

Description:

Location 1 : Monoculture with cover crops without pruning

Location 2 : Multi-stratum plants and pruning

Location 3 : Polyculture without protective plants

Location 4 : Monoculture with cover crops

Location 5 : Polyculture without protective plants



Figure 2. Characteristics of the People's Coffee Cultivation System var Arabica Sigarar Deb in the Lake Toba Area

The results of field observations showed that the intensity of *Helopeltis* sp. attacks on smallholder coffee

The high intensity of attacks is found in locations 1 and 4 with an average of 57.80% and 56.80%, where the leaf buds dry out and new growth is formed by rosette shoots where the shoots grow tightly and shorten and do not develop, thus this location is classified as in the weight scale category. Furthermore, locations 3 and 4 are classified in the medium category scale. Meanwhile, at location 2 with a multi-stratum planting system and pruning, the attack intensity was the lowest on a light category scale. Arabica coffee plants are a type of coffee that adapts to altitudes above 700 meters above sea level and require protective plants. High *Helopeltis* sp. attacks that occur in coffee plantations in monoculture locations

with protective plants, environmental conditions that are not managed according to GAP guidelines for coffee plants include not pruning unproductive twigs, not pruning protective plants.

In coffee plants, shade plants also play a role in suppressing pest attacks. Therefore, shade management is important so that the shade used does not become an alternative host for these pests and creates conditions that support the development of pests (Evizal et al., 2009; Bosselmann et al., 2009; Indriati, 2014; Muñoz-Villers et al., 2020). Furthermore, Saragih (2017) and Dufour et al. (2019) show that almost all smallholder coffee plantations that have been carried out by farmers are still on a small scale and are said to be poorly managed due to a lack of training in increasing farmers' capacity in managing coffee in accordance with GAP and weak knowledge agroecology. The pruning model used by farmers is pruning after the harvest period by removing unproductive branches, including branches that have borne fruit 2-3 times, wild branches, back branches, branches attacked by pests and diseases. There are still farmers who do not prune, allowing coffee plantations to grow tall, so that coffee farmers are still found with very low jug production, only 200 kg /ha/ year. It is important to carry out pruning on coffee plantations on the plants themselves and on protective plants, by pruning it will reduce the growth of unproductive twigs and minimize the suitability of habitat and microclimate for the development of pests and plant diseases (Giovannucci & Ponte, 2005).

The Influence of Monoculture and Polyculture on the Intensity of Attacks by Helopeltis sp.

Based on planting patterns, people's coffee plantations in North Tapanuli have monoculture and polyculture systems using intercropping between rows of coffee plants. As a result of interviews and checks at the location of people's coffee plantations using a polyculture system, various types of annual plants were used as intercrops. Identified intercrops planted between rows of coffee plants include legumes, namely red beans, soybeans, peanuts; vegetable plant groups, namely shallots, chilies, lettuce, eggplant, mustard greens, others from the rhizome plant group, taro, Dutch eggplant (Figure 2). The results of observations at the research location regarding damage to coffee plants due to attacks by *Helopeltis* sp. It was found that all research locations on people's coffee plantations in the Lake Toba area were attacked by *Helopeltis* sp. from low to severe levels of damage.

The t test results compared the level of damage to coffee plants due to attacks by *Helopeltis* sp. between polyculture gardens and monoculture; between gardens with protective plants and without protective plants,

between gardens with pruning and gardens without pruning, the results are as follows.

Table 1. Results of the T Test for the Intensity of Coffee Plant Attacks Due to *Helopeltis* sp Attacks in Various Cultivation Systems

| Cultivation system | t _{count} | t _{table} | Information |
|--|--------------------|--------------------|------------------|
| With cover crops x Without cover crops | 8.836 | 2.306 | Really different |
| Monoculture x polyculture | 8.921 | 2.306 | Really different |
| Crop x no crop | 8.097 | 2.306 | Really different |

The system of intercropping of coffee plants (polyculture) had a significant influence on the low intensity of *Helopeltis* sp. attacks, where t_{count} (8.921) > t_{table} (2.306). The intercropping cultivation system, which means planting two or more types of plants on the same land, has become popular nowadays and is widely practiced by farmers in developing countries (Syakir & Surmaini, 2017; Gaitán-Cremaschi et al., 2018; Ram, 2018). Intercropping plays a role in increasing insect diversity and maintaining the stability of agroecosystems. This is in accordance with Nurindah et al. (2008) who said that the polyculture planting system is more profitable because the diversity and population of natural enemies are relatively high compared to the monoculture planting system. One of the stability of agroecosystems is shown by the balance between insect pests and insects that have the potential to act as natural enemies so that plant damage can be reduced below the economic threshold (Manson, 2022; Untung, 2006; Pangaribuan et al., 2020; Suswati et al., 2022). The use of intercropping with various types of vegetables, nuts and rhizomes between rows of coffee plants makes the microhabitat more supportive as a breeding ground for natural enemies, both insects and microbes. The application of intercropping patterns has a significant effect on the percentage of pest attacks. The percentage of pest attacks in intercropping cropping patterns is lower compared to monoculture cropping patterns. This is thought to be because the intercropping pattern, apart from providing nectar from flowers needed by parasitoid and predatory insects (Saputra et al., 2023; Allifah, 2013; Kurniawati & Martono, 2015; Suswati et al., 2021; Azwana & Sihotang, 2023), also contains repellent compounds for insect pests (Nurdiansyah et al., 2016; Suzanti et al., 2016). The use of intercropping increases plant diversity in the field which can suppress pest attacks and increase the performance of natural enemies (Nirmayanti et al., 2015).

Conclusion

On this research, it can be conclude that *Helopeltis* sp. sucking shoot pests have been known to attack coffee

plants in North Tapanuli Regency with symptoms of attack. At the start of the attack, leaf spots are visible which are brown, curly and eventually dry out, die (die back), then grow rosettes, namely new shoots that shorten tightly and not developing. The intensity of *Helopeltis* sp. attacks on smallholder coffee plantations in North Tapanuli Regency is quite varied, from light to heavy attacks with the intensity of shoot attacks ranging from 15.67% to 57.80%. Monoculture coffee plantations with protective plants, but no pruning, are locations with *Helopeltis* sp. attack levels in the heavy category with shoot attack intensity reaching 56.66%. The intercropping coffee plant cultivation system (polyculture) had a significant influence on the low intensity of *Helopeltis* sp. attacks, where $t_{\text{count}} (8.921) > t_{\text{table}} (2.306)$.

Acknowledgments

We thank to the all person/institution who helped this research.

Author Contributions

Retna Astuti Kuswardani conceptualized the research idea, designed of methodology, management and coordination responsibility; Siti Mardiana and Suswati analyzed data, conducted a research and investigation process; Saipul Sihotang conducted literature review and provided critical feedback on the manuscript.

Funding

This research received no external funding.

Conflicts of Interest

The author declared no conflict of interest.

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