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The Study of Diversity and Intensity of Pest Attacks on Arabica Coffee *(Coffea arabica* L.) Plantations in Kutarayat Village, Naman Teran District, Karo Regency

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Abstract

The high demand for Arabica coffee (Coffea arabica L.) in North Sumatra must be accompanied by high productivity as well. One of the challenges often faced by coffee farmers is pest attacks. One way to address this issue is by conducting surveys on pest diversity and the intensity of pest attacks on coffee plantations. This study is a descriptive quantitative analysis with a cluster sampling method (sampling area) using yellow traps. The observation area covers 5 hectares, spread across 5 hamlets. Each hamlet consists of 5 plots, with each plot covering an area of 250 m². The observation period was divided into 4 sessions: morning, afternoon, evening, and night. The results of the observations showed that in Block 1, the total number of Diptera order was 105 individuals with a KR value of 77.5%, and the lowest order was Orthoptera with only 1 individual and a KR value of 3%. In Block 2, the order Diptera had 103 individuals with a KR value of 79.75%, and the lowest order was Odonata with 1 individual and a KR value of 2%. In Block 3, the most frequent order was Diptera with 57 individuals and a KR value of 68%, while the lowest order was Neuroptera with 1 individual and a KR value of 3%. In Block 4, the most frequent order was Hymenoptera with 59 individuals and a KR value of 39.5%, and the lowest order was Neuroptera with 1 individual and a KR value of 3%. In Block 5, the most frequent order was Diptera with a total of 60 individuals and a KR value of 65.5%, while the lowest order was Coleoptera with 1 individual and a KR value of 5%

Keywords: *Arabica coffee; Intensity; Pest*

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INTRODUCTION

Indonesia is one of the largest coffee producers and the fourth-largest coffee exporter globally, alongside Vietnam, Brazil, and Colombia. Coffee has been among the most popular beverages produced by humans for centuries. Indonesian Arabica coffee is well-known in the global market for its exceptional flavor. Arabica coffee is considered a high-quality specialty coffee due to its unique, complex, and strong aroma, making

it popular among coffee enthusiasts and a prominent global commodity. Arabica coffee is highly favored by farmers as it offers many advantages, such as early fruiting, relatively high productivity, and excellent quality (Najwa et al., 2024). In today's era, coffee has become a primary beverage rather than merely a complement (Adinda et al., 2024). Arabica coffee contains bioactive compounds that exhibit anti-inflammatory, antihyperglycemic, anticellulite, anti-hyperuricemia, antimicrobial, and antioxidant properties (Muharam & Sriwidodo, 2022).

According to data from BPS (2019), North Sumatra's coffee production experienced a gradual increase from 2019 to 2021, starting with a production figure of 66,831.00 tons in 2019 and reaching 71.588.00 tons in 2021. The area of land under cultivation also expanded, from 77.765.00 hectares in 2019 to 79.388,64 hectares in 2021. This indicates a significant increase in the popularity of Arabica coffee cultivation in the North Sumatra region.

Arabica coffee grows at an altitude of 700 to 1.700 meters above sea level. This plant can grow up to 3 meters tall under favorable environmental conditions. Its optimal growth temperature is 16 to 20°C. Robusta coffee can be cultivated at altitudes below 800 meters above sea level. According to Susilo & Wicaksono (2023), the growth requirements for Arabica coffee include an altitude of 1,000-1,500 meters above sea level, a pH of 5.5 – 6.0, organic carbon content of 2 to 5 %, sandy loam soil texture, and good drainage, all of which fulfill the proper planting conditions for Arabica coffee (Purba et al., 2023).

Karo regency is an Arabica coffee-producing region in North Sumatra, supported by environmental factors (soil, climate, altitude, and temperature) that are highly favorable for coffee growth. Karo regency is recognized as one of the coffee-producing areas in North Sumatra due to its conducive environmental conditions (soil, climate, altitude, and temperature) that promote coffee cultivation. In Karo regency, the cultivated land area increased from 5.261 hectares to 9.754 hectares between 2010 and 2019. Alongside this, coffee production also rose from 4.984,51 tons to 13.445,56 tons (Ginting et al., 2022). However, this suboptimal production is attributed to several challenges faced by coffee farmers, including climate change, limited technology and knowledge, seed quality, and pest and disease infestations (Ginting et al., 2022). Pests are considered plant-disturbing organisms (PDO) that cause damage to crops and act as sources of plant diseases (Octaviana & Ekawati, 2022).

According to by Nadiawati et al., (2023) research, coffee production in Kerinci regency from 2015 to 2017 experienced a decline, starting from 208 tons, 166 tons, and down to 74 tons. Based on this data, it can be seen that Arabica coffee production over the past four years has been decreasing. This condition is caused by various factors, one of which is the attack of Coffee Berry Borer (called PBKo). The spread of coffee berry borer in Indonesia is heavily influenced by environmental factors such as temperature, humidity, and altitude. These factors cause the level of damage and the abundance of coffee berry borer populations to vary across different regions.

The importance of data on pest types in coffee plants for sustainable control is crucial, as each pest variety requires a specific control approach. Currently, there is no data available on coffee plantation pests in Karo regency. Therefore, an in-depth study of the types of pests present in the coffee plantations of Karo regency is necessary.

Based on this background, the authors are interested in conducting research on the agroecosystem study of Arabica coffee plantation pests (*Coffea arabica* L.) in Kutarayat village, Naman Teran district, Karo regency.

METHOD

Sample or Participant

This research was conducted in Kutarayat Village, Naman Teran District, Karo regency, North Sumatera Province, at an altitude of approximately 1.450 meters above sea level. The materials used in this study included adhesive or glue, soapy water, sugar water or honey (optional). The tools used in this research included yellow traps, a ruler, scissors, string or thread, nails or clips, a documentation tool (camera), writing tools, an identification book or key, and other supporting research equipment.

Research Methods

Sample Collection Method

This research employed a quantitative descriptive analysis method using cluster sampling (sampling area), which involves sampling by grouping based on the research area or location. This study utilized yellow traps (Jannah et al., 2023). The observation area covered 5 hectares spread across 5 hamlets, with each hamlet consisting of 5 plots, each plot measuring 250 m². The observation period was divided into four sessions: morning, midday, afternoon, and evening.

Observation of Arabica Coffee Plant Parameters

Before observing pests, the coffee plantation area to be used for observation was determined. Prior to the installation of yellow traps, the age of the plants (data from the plantation owner) was recorded, and measurements were taken for plant height, canopy width, planting distance, and soil pH.

Insect Identification

Insects that have been trapped were then identified using Google Lens and an insect identification guidebook by observing their morphological characteristics. The identification book used was "The Insects of Australia" by Cornell University Press (1970).

Data Analysis

Absolute Frequency (FM)

Absolute frequency indicates the number of individuals of a particular insect species found in a habitat, expressed in absolute terms (Surya et al., 2020).

$$\text{FM} = \frac{\text{The number of individuals of a particular insect species found}}{\text{The total number of captures}}$$

Relative Abundance (KR)

The relative abundance of an insect is calculated using the formula for

relative abundance (KR), Surya et al., (2020):

$$\text{Relative abundance } (KR) = \frac{ni}{N} \times 100\%$$

Description:
Ni : Number of individuals and species of the first type (species I);
N : Total number of individuals;

Intensity Of Presence

Assessment of plant damage can be made based on the symptoms of pest attacks (PDO) which vary greatly. For calculating/assessing pest attacks that cause absolute damage or are considered absolute, the following formula is used (Surya et al., 2020):

$$I = \frac{a}{b} \times 100\%$$

Description :
I = Attack Intensity (%)
a = Presence of species a in each plot
b = Total plots

RESULT AND DISCUSSION

Plant Parameters

The results of the coffee observation in Kutarayat Village, Naman Teran District, Karo regency showed that the average age of the coffee plants there is approximately ± 5 years. The height of the coffee plants in Block 1 is about 165 cm, in Block 2 it is 91 cm, in Block 3 it is 180 cm, in Block 4 it is 120 cm, and in Block 5 it is 240 cm. For the canopy width of the coffee plants in Kutarayat Village, Block 1 has a canopy width of 220 cm, Block 2 has a width of 140 cm, Block 3 has a width of 258 cm, Block 4 has a width of 160 cm, and Block 5 has a width of 260 cm.

Table 1. Results of the observation of Arabica coffee (*Coffea arabica* L.) plant parameters

No	Description	Block 1	Block 2	Block 3	Block 4	Block 5
1	Plant Age (Year)	5	4	6	5	6
2	Plant Height (cm)	165	91	180	120	240
3	Canopy Width (cm)	220	140	258	160	260
4	Planting Distance (cm)	330	230	250	230	250
5	Soil pH	7	6,7	6,5	6,9	7

The planting distance in Kutarayat Village varies in each block: in Block 1, the planting distance is approximately 330 cm, in Block 2 it is about 230 cm, in Block 3 it is about 250 cm, in Block 4 it is about 230 cm, and in Block 5 it is about 250 cm. According to Darmawan et al., (2024), planting distance significantly affects the growth of taro plants. The soil in the coffee plantation of Kutarayat Village has a very stable pH, with an average pH of 6.8. According to Pratama et al., (2021),

the differences in canopy width and coffee plant height are caused by several factors such as temperature, and altitude, which is the main factor.

Pest Diversity

Based on observations in Block 1, the pests found in the morning were from the order Diptera, which was the most prevalent pest attacking coffee plants with a total of 31 pest species. Araneae was the lowest order affecting the coffee plants in Block 1 during the morning. In the afternoon, the order Diptera was also the most prevalent pest attacking coffee plants with a total of 21 species in each plot of Block 1, while the least prevalent pests were from the orders Orthoptera and Hemiptera, with one species each in every plot of Block 1 during the afternoon. In the evening, Diptera was again the most prevalent order attacking the plants, with a total of 38 species across all plots in Block 1. Lepidoptera was the least prevalent order in the evening, with only one pest species found in all plots of Block 1. At night, Diptera remained the most abundant order attacking coffee plants with a total of 40 pest species across all plots, while the least prevalent pests were from the order Hymenoptera, with only two species across all plots.

Table 2. Results of pest observation in Block 1

	Ordo	Total	FM	KR (%)	Presence Intensity (%)
Morning	*Diptera*	31	0,79	79	100
	Coleoptera	6	0,15	15	20
	Araneae	2	0,05	5	40
Afternoon	*Diptera*	21	0,75	75	100
	Hymenoptera	5	0,17	17	80
	Orthoptera	1	0,03	3	20
	Hemiptera	1	0.03	3	20
Evening	*Hymenoptera*	13	0,25	25	20
	Diptera	38	0,73	73	100
	Lepidoptera	1	0.01	1	20
Night	*Diptera*	40	0,83	83	100
	Lepidoptera	6	0,12	12	20
	Hymenoptera	2	0,04	4	40

The abundance of Diptera pests was influenced by one factor: the coffee plants were about 100 meters away from chili pepper plants. This was proven by Oktavianda et al., (2019), where the abundance of Diptera (609 individuals) was dominated by fruit flies due to the migration of insects from orange groves, which were located about 500 meters away. Integrated Pest Management (IPM) is the primary solution for controlling these pests, as it is an effective decision to protect plant quality from biotic stress and enhance agricultural production, soil health, and the environment (Baker et al., 2020).

Figure 1. Attack of the *Phyllium puchrifolium*

Based on pest diversity and the intensity of pest presence in Block 1, the highest pest density in the morning was from the order Diptera, with a density of 79 %, while Araneae had the lowest density at 5 %. In the afternoon, Diptera also had the highest pest density at 75 %, while Orthoptera and Hemiptera had the lowest pest densities, each at 3 %. In the evening, Diptera had the highest pest density at 73 %, and Lepidoptera had the lowest at 1%. At night, Diptera also had the highest pest density at 83 %, while Hymenoptera had the lowest at 4%. The order with the highest density of pests, according to Table 1, was Diptera. This order showed the highest density during all observation times (morning, afternoon, evening, and night), with very significant percentages: 79 % in the morning, 75 % in the afternoon, 73 % in the evening, and 83 % at night.

The high density of Diptera pests was influenced by their high adaptability to various environmental conditions. The order Diptera consists of flies, which are well-known and widely distributed insects around the world, occupying almost all terrestrial and aquatic habitats (Sarwar, 2020). The factors causing Diptera to appear at every observation time were due to their tendency to be more active in the morning when temperatures are cooler and humidity is higher, supporting their activities. In the afternoon, some flies remain active, especially in shaded areas, and continue their activity in the evening and at night. Additionally, orders that appeared only at specific times included Coleoptera and Araneae, which were only present in the morning. Many beetles are active in the morning because of the cooler temperatures and higher humidity, helping them avoid predators and reduce water loss through evaporation. In the afternoon, Orthoptera appeared as grasshoppers, which are often more active during the day as they require sunlight to boost their metabolic activities. Hardiansyah & Noorhidayat (2020) stated that temperature, light, and humidity play important roles in the growth, development, metabolism, and reproduction of insects.

In the evening and at night, Lepidoptera was present, as some moths begin to be active in the late afternoon to seek food and mates. Pest groups with high intensity of presence (100 %), like Diptera in all observation times, indicate that these pests consistently attack every plot, while pest groups with high intensity at specific times,

such as Hymenoptera in the afternoon and evening, also showed significant patterns of activity.

Table 3. Pest Observation Results Block 2

	Pest Species	Total	FM	KR (%)	Presence Intensity (%)
Morning	*Diptera*	20	0,90	90	80
	Hymenoptera	2	0,09	9	40
Afternoon	*Diptera*	38	0,97	97	100
	Odonata	1	0,02	2	40
Evening	*Diptera*	19	0,76	76	100
	Hymenoptera	4	0,16	16	60
	Lepidoptera	1	0.04	4	20
	Neuropoda	1	0,04	4	20
Night	*Diptera*	26	0,56	56	100
	Hymenoptera	7	0,15	15	40
	Coleoptera	12	0,26	26	40
	Lepidoptera	1	0,02	2	20

Anthophila (bees) is the most abundant pest in Block 2 with a population of 34 individuals. According to Hamilton et al., (2019), migration can occur due to pesticide exposure from agricultural activities, limited availability of flowers, or competition for food sources between bees. Wild bees also migrate to find new food sources because the food availability in one place becomes scarce. *Apis dorsata* is one of the bee species that migrates frequently, with migration occurring 2-3 times a year. This migration process is an adaptation of wild honeybees to the need for food sources to support the colony's reproduction.

The pest *Gryllidae* (crickets) causes the least damage in Block 2 with a population of 2 individuals. Crickets damage fruit trees in two ways. The most noticeable damage occurs during the egg-laying process, where the slit created by the female in the small branches weakens them; often the weak branches break due to wind. Under heavy attack, most of the branch tips may die. On larger trees, where the branches are thicker than the size preferred for laying eggs, the loss of most branch tips may not damage the tree severely. According to Nisa (2020), crickets damage plants by biting and feeding on the young stems, which in turn affects the economic value of the plants.

Based on Table 2, the highest pest density in the morning is the order *Diptera* with a result of 90 %, while *Hymenoptera* is the order with the lowest density at 9 %. In the afternoon, *Diptera* remains the order with the highest pest density at 97 %, while *Odonata* has the lowest density with a percentage of 2 %. In the afternoon, *Diptera* again has the highest density at 76 %, while *Lepidoptera* and *Neuropoda* each have only 4 %. At night, *Diptera* still has the highest density at 56 %, while *Lepidoptera* has the lowest at only 2 %.

The order *Diptera* shows the highest density across all observation times (morning, afternoon, evening, and night) with very significant percentages: 90% in the morning, 97 % in the afternoon, 76 % in the evening, and 56 % at night. The highest pest density in the order *Diptera* is influenced by the organic residues from the

harvesting and processing of coffee fruit, which serve as a food source for *Diptera* larvae. The lack of good sanitation practices in coffee farms can increase the fly population due to the abundance of organic material. The appearance of *Diptera* at each observation time is because flies tend to be active in the morning when temperatures are relatively cool, and humidity is higher, which supports their activity. During the afternoon, some flies remain active, especially in shaded areas, and their activity continues during the evening and night.

Additionally, other orders that appear at specific times include *Hymenoptera*, which appears in the morning because of the cool temperature and newly opened flowers offering fresh nectar. In the afternoon, *Odonata* appears as they are more active during the day, hunting prey near water when temperatures are warmer. Strong sunlight helps them hunt and navigate. In the evening, *Neuroptera* is more active due to the appearance of many small prey at this time, and their activity decreases during the day because excessive heat inhibits their movement. At night, *Coleoptera* is more active as dark beetles prefer the night to search for food and mates, as well as to avoid daytime predators. The pest group with high presence intensity (100 %), such as the order *Diptera* at all observation times, indicates that this pest consistently attacks each plot. Pest groups with high presence intensity at specific times, such as *Hymenoptera* in the morning, evening, and night, also show similar patterns

Figure 2. Pest Attack of *Bactrocera carambolae*

Block 3

Based on Table 4, the observation results for Block 3 show a total of 90 pest insect species. The pest species Lasius (black ant) is the most common in Block 3 with a population of 36 individuals. Ants are important predators and are predicted to protect plants from pests. Their presence is especially noticeable during the dry season, when ants tend to come out in large numbers and can eventually hinder plant growth (Supriati et al., 2019). On the other hand, the pest species *Cotinis nitida* (beetle) is the least captured insect pest in Block 3. Beetles are from the Coleoptera order, a group of insects commonly found on plant canopies, soil surfaces, or between soil particles (Toly, 2019). Beetles are occasional pests of ripe fruits. They can fly relatively long distances and are highly attracted to ripe fruits, manure, and fermented fruits. To avoid damage caused by these beetles, it is recommended to plant varieties that ripen earlier than those that ripen later. Harvest fruits earlier and discard fallen fruits. Using insecticides for beetles is not recommended. Control the larvae to prevent damage

caused by adult beetles. Remove or spread out any piles of compost, grass clippings, leaves, and manure near fruiting trees.

Table 4. Results of Pest Observation in Block 3

	Pest Species	Total	FM	KR (%)	Presence Intensity (%)
Morning	*Diptera*	11	0,84	84	100
	Coleoptera	1	0,07	7	20
	Hymnoptera	1	0,07	7	20
Afternoon	*Diptera*	9	0,39	39	80
	Hymenoptera	8	0,34	34	60
	Coleoptera	6	0,26	26	60
Evening	*Diptera*	15	0,65	65	100
	Hymenoptera	7	0,30	30	60
	Araneae	1	0.04	4	20
Night	*Diptera*	22	0,84	84	100
	Lepidoptera	2	0,07	7	60
	Araneida	1	0,03	3	20
	Neuroptera	1	0,03	3	20

Based on the results of the data contained in the block 3 show that the high number of black ant attacks is mainly due to the land's condition, which is quite dense with weeds and shading trees. The temperature in Block 3 is relatively high, around 24°C, with an altitude of 1.259 meters above sea level. The coffee plants in Block 3 are 4 to 5 years old. Black ants are a pest that needs to be controlled because they affect agricultural activities such as maintenance and coffee harvesting. The control of black ants is carried out in an integrated manner using both mechanical (trapping) and chemical methods. Trapping is done by applying an innovative method from Bangelan Estate, which involves placing bamboo that has been covered with coffee leaves and molasses, as well as removing host plants/weeds. This method has been effective in controlling pests.

According to Table 3, the highest pest density in the morning is from the order Diptera, with a result of 84 %, while Hymenoptera and Coleoptera are the orders with the lowest density, each at 7 %. In the afternoon, the order Diptera is also the highest in pest density, with a total of 39 %, while the lowest density is from the order Coleoptera, at 26 %. In the evening, Diptera remains the highest in pest density at 65 %, while the lowest are Araneae, at 4 %. At night, the order Diptera is still the highest, with a density of 84 %, while Araneidae and Neuroptera are the lowest at 3 %.

The order Diptera has the highest density according to Table 3. This high density is observed across all times of observation (morning, afternoon, evening, and night) with significant percentages: 84 % in the morning, 39 % in the afternoon, 65 % in the evening, and 84 % at night. The highest pest density in the Diptera order indicates that Diptera, especially fruit flies, are often found in coffee plantations because ripe coffee fruits that fall to the ground provide a food source rich in sugars and fermentation. This condition attracts flies to breed and feed around the coffee plants. The reason for the consistent presence of Diptera at all observation times is because Diptera, such as flies, tend to be active in the morning when temperatures are

still relatively cool and humidity is higher, which supports their activity (Warsito, 2023).

Moreover, the Coleoptera order only appears in the morning and afternoon. Many beetles are active in the morning because the temperature is still cool and the humidity is relatively high, helping them avoid predators and reduce water loss through evaporation. In the evening and night, the Araneae order becomes active. Pest groups with high presence intensity (100%) such as the Diptera order across all observation times show that these pests consistently attack each plot, while pest groups with high presence intensity at certain times include the Coleoptera order in the morning and afternoon.

Figure 3. Pest Attack of *Leucoptera coffeina*

Block 4

Based on Table 4, the highest pest density during the morning was found in the order Diptera with a result of 65 %, while Odonata and Hemiptera were the orders with the lowest density, each with 5 %. In the afternoon, the Diptera order also had the highest pest density at 89 %, while the lowest density was found in Coleoptera and Hymenoptera with 5 % each. In the evening, the highest density was found in Hymenoptera at 70 %, while Orthoptera had the lowest density at 2 %. At night, the highest density was again in Hymenoptera at 68 %, while the lowest density was found in the order Neuroptera at 3 %.

Ants are one type of insect that, when their numbers become excessive, can disturb comfort during activities. Additionally, ants can cause damage and even spread diseases. Because of this, many insecticides have been produced to eradicate ants (Alvareza et al., 2020). However, the chemical substances in insecticides can create new problems for the surrounding environment. These chemicals are often toxic to humans. Due to the harmful effects of these toxins in insecticides on human health, many researchers have been studying natural plants that can be used as an alternative to insecticides for eradicating insects (Sinambela, 2024).

The insect order with the highest density based on Table 4 is Diptera and Hymenoptera. The highest density of the Diptera order is observed during the morning and afternoon observations, with significant percentages: 65 % in the morning and 89 % in the afternoon, while Hymenoptera showed high density during the afternoon and evening, with 70 % in the afternoon and 68 % at night. The highest pest density in the Diptera order is influenced by the microclimate humidity beneath the coffee plant canopy, which creates an ideal environment for various Diptera species. The humid microclimate, protected from direct sunlight, helps maintain a high population of flies.

Table 5. Pest Observation Results Block 4

	Pest Species	**Total**	**FM**	**KR (%)**	**Presence Intensity (%)**
Morning	*Diptera*	13	0,65	65	100
	Hymenoptera	3	0,15	15	20
	Araneae	2	0,1	10	20
	Odonata	1	0,05	5	20
	Hemiptera	1	0,05	5	20
Afternoon	*Diptera*	17	0,89	89	80
	Coleopteran	1	0,05	5	20
	Hymenoptera	1	0,05	5	20
Evening	*Coleopteran*	1	0,02	2	20
	Diptera	12	0,25	25	80
	hymenoptera	33	0.70	70	80
	Orthoptera	1	0,02	2	20
Night	*Diptera*	9	0,28	28	80
	neuroperan	1	0,03	3	20
	hymenoptera	22	0,68	68	100

The factor that causes Diptera to appear at all observation times is that Diptera, such as flies, tend to be active in the morning because the temperature is still relatively cool and the humidity is higher, which supports their activity. During the afternoon, some flies remain active, particularly in shaded areas, and their activity continues into the evening and night. Additionally, the order Araneae only appears at certain times, mainly in the morning. Many beetles are active in the morning due to the cooler temperatures and sufficient humidity. This helps them avoid predators and reduce water loss through evaporation. During the afternoon, the Coleoptera order is active, while during the evening and night, the Orthoptera and Neuroptera orders are observed. Pest groups with high intensity of presence (100 %) such as Diptera and Hymenoptera during the morning and afternoon observations show that Diptera consistently attacks each plot, as does Hymenoptera during the evening and night observations.

Block 5

According to Table 5, the highest pest density during the morning observation was found in the order Diptera at 52 %, while Araneae and Orthoptera had the lowest density at 5 %. In the afternoon, Diptera still had the highest pest density at 56 %, while Hymenoptera had the lowest density at 43 %. In the evening, Diptera again had the

highest density at 84 %, while the lowest was Hymenoptera at 12 %. At night, Diptera still had the highest density at 70 %, with the lowest densities found in Hemiptera and Coleoptera at 5 %.

Based on the observations in block 5, the most frequent attacks from bees and fruit flies were due to the presence of a relatively dense cover of weeds, humid conditions, and the flowering Lamtoro trees. The coffee plants in block 5 are 7 years old. The high humidity in block 5 is due to the dense and thick shading trees. The temperature in block 5 is quite high at 24 °C, with an altitude of 1.258 meters above sea level. Weeds can serve as a resting place for fruit flies (an alternative host), so they should be removed. Certain types of weeds may attract fruit flies. The attack of fruit flies is characterized by small holes on the surface of almost ripe fruit. The damage is caused by the larvae feeding on the fruit flesh, which triggers rotting, peeling, and fruit falling off, leading to decreased productivity (Sari, 2024).

Tabel 6. Pest Observation Results Block 5

	Pest Species	Total	FM	KR (%)	Presence Intensity (%)
Morning	*diptera*	9	0,52	52	80
	hymenoptera	6	0,35	35	60
	araneae	1	0,05	5	20
	orthoptera	1	0,05	5	20
Afternoon	*Diptera*	18	0,56	56	80
	hymenoptera	14	0,43	43	80
Evening	*Diptera*	21	0,84	84	60
	araneae	1	0,04	4	20
	hymenoptera	3	0.12	12	40
Night	*diptera*	12	0,70	70	80
	hymenoptera	3	0,17	17	40
	Hemiptera	1	0,05	5	20
	Coleoptera	1	0,05	5	20

The insect order with the highest density in block 5 is Diptera. The highest density of this order was observed at all observation times (morning, afternoon, evening, and night) with significant variations: 52 % in the morning, 56 % in the afternoon, 43 % in the evening, and 84% at night. The pest group with a high intensity of presence (100 %) like Diptera on all observation times shows that this pest consistently attacks each plot.

Integrated Pest Management (IPM) could be a solution for pest control. IPM is a pest control technique that aims to keep pest populations below an economic threshold and minimize the negative impacts of pesticides on the environment and humans. The application of IPM based on ecological engineering is a strategy to increase plant diversity with the goal of creating a habitat suitable for natural enemies to live and reproduce in order to control pests naturally (Widhayasa et al., 2023). Insecticides are often the primary choice for pest control, but their application not only kills target pests but also poses dangers to the environment and humans (Isman, 2019). Continuous insecticide applications can lead to pest resistance and resurgence due to the death of natural enemies of the pest (Akter et al., 2019). The use of pesticides that do not follow regulations or standards can cause health issues and environmental

pollution, disrupting ecosystems (Ibrahim & Sillehu, 2022). Pesticide residues can harm humans if they enter the food chain, leading to diseases like cancer, mutations, birth defects, and more (Bernik & Setiawan, 2019).

The use of chemicals should be done wisely and according to recommended guidelines to reduce the risks of harmful chemical residues and to maintain the quality of the final product. Effective pest control not only involves the proper techniques but also education and training for farmers on the importance of monitoring plant conditions and early pest attack detection. By implementing this integrated approach, it is expected that coffee plantations can minimize losses caused by pests, maintain plant health, increase productivity, and preserve environmental sustainability and social welfare in the surrounding areas. In the global context, which increasingly demands sustainability and the wise management of natural resources, effective pest control in coffee plantations is a crucial component in achieving these goals.

CONCLUSION

Based on the observations of pests in blocks 1, 2, 3, and 5, they are dominated by pests from the order Diptera. Meanwhile, block 4 is dominated by the Hymenoptera order. In block 1, the total Diptera order is 105 individuals with a KR value of 77.5 %, and the lowest is the Orthoptera order with 1 individual and a KR value of 3 %. In block 2, Diptera has 103 individuals with a KR value of 79.75 %, and the lowest is the Odonata order with 1 individual and a KR value of 2 %. In block 3, the most common order is Diptera with 57 individuals and a KR value of 68 %, and the lowest is the Neuroptera order with 1 individual and a KR value of 3 %. In block 4, the most common order is Hymenoptera with 59 individuals and a KR value of 39.5 %, and the lowest is the Neuroptera order with 1 individual and a KR value of 3 %. In block 5, the most common order is Diptera with a total of 60 individuals and a KR value of 65.5 %, and the lowest is Coleoptera with 1 individual and a KR value of 5 %.

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