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Population Abundance and Infestation Intensity of *Helopeltis theivora* (Hemiptera: Miridae) in Cocoa Plantations of Lima Puluh Kota Regency, Indonesia

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ABSTRACT

Cacao (*Theobroma cacao* L.) is a key tropical commodity whose productivity is significantly constrained by insect pests, particularly mirid bugs such as *Helopeltis theivora*. This study aimed to quantify the population abundance and infestation intensity of *H. theivora* and to analyze their association with agroecosystem management practices in cocoa plantations of Lima Puluh Kota Regency, West Sumatra, Indonesia. Field surveys were conducted across six villages using purposive site selection followed by random sampling of plants. Pest populations were assessed through chemical knockdown and manual collection, while infestation levels were determined using standard percentage and intensity indices. A total of 206 individuals were recorded, with nymphs (63.6%) dominating the population structure. Pest abundance ranged from 0.05 to 0.35 individuals per stem. Infestation levels varied significantly across locations, with the highest infestation percentage (51.76%) and intensity (41.13%) observed in poorly managed plantations, while the lowest values (35.89% and 31.88%) occurred in well-maintained systems. Variations in pest dynamics were strongly associated with differences in sanitation, pruning, and pesticide application. The findings highlight the critical role of agroecological management and natural enemy conservation in regulating *H. theivora* populations. This study provides an empirical basis for developing location-specific integrated pest management (IPM) strategies to enhance cocoa productivity in tropical agroecosystems.

Keywords: Cocoa agroecosystem, damage intensity, *Helopeltis theivora*, integrated pest management, mirid bug.

INTRODUCTION

Cocoa (*Theobroma cacao* L.) is one of the most economically important plantation crops globally, serving as a key raw material for the chocolate industry and contributing significantly to the livelihoods of millions of smallholder farmers in tropical regions. Globally, cocoa production is concentrated in West Africa, Southeast Asia, and Latin America, with Indonesia consistently ranked among the top three cocoa-producing countries (BPS, 2023). Beyond its contribution to global trade, cocoa plays a crucial role in supporting rural economies, promoting agro-industrial development, and generating employment opportunities (Puspita et al., 2015).

In Indonesia, cocoa remains a strategic commodity within the plantation sector, with a total plantation area of approximately 1.49 million hectares and production reaching 728,046 tons in 2021 (Ditjenbun, 2021). However, despite its economic importance, the Indonesian cocoa sector has experienced a steady decline in both plantation area and productivity over recent years. Between 2017 and 2021, cocoa plantation area decreased from 1.66 million hectares to 1.49 million hectares, reflecting structural challenges in cocoa cultivation, including aging plantations, suboptimal management practices, and increasing pressure from pests and diseases (Ditjenbun, 2021).

At the regional level, West Sumatra Province represents an important cocoa-producing area in western Indonesia, with a plantation area of 68,710 hectares and an annual production of approximately 43,528 tons (BPS, 2023). Within this province, Lima Puluh Kota Regency is recognized as a promising center for cocoa development, covering approximately 6,697 hectares of cultivated land (BPS, 2021). As with national trends, cocoa productivity in this region has declined over the past five years. One of the primary factors contributing to this decline is the increasing incidence of plant pests and diseases, which can cause yield losses ranging from 30% to 60% annually (Ikhsan et al., 2024; Sulystiowati et al., 2008).

Among the major insect pests affecting cocoa production, the cocoa mirid bug, *Helopeltis theivora* (Hemiptera: Miridae), is considered one of the most destructive. This pest damages cocoa by piercing and sucking sap from young shoots, pods, and stems, resulting in necrotic lesions, premature fruit drop, and reduced bean quality (Atmadja, 2003). Severe infestations can significantly reduce yield and, in extreme cases, lead to crop failure. The life cycle of *H. theivora* consists of egg, nymph, and adult stages, with nymphs and adults actively feeding on plant tissues. The relatively short life cycle and high reproductive capacity—females lay 30–60 eggs during their lifespans—enable rapid population build-up under favorable environmental conditions (Atmadja, 2003).

The population dynamics and infestation levels of *H. theivora* are strongly influenced by ecological factors, including temperature, humidity, host plant availability, and agroecosystem management practices. Polyculture systems, shade management, pruning, sanitation, and the presence of natural enemies such as ants and spiders play significant roles in regulating pest populations (Siswanto & Karmawati, 2012; Wijngarden, 2007). For instance, beneficial insects such as *Dolichoderus thoracicus* and *Oecophylla smaragdina* have been reported to suppress mirid populations through predation and interference, thereby reducing crop damage (Way & Khoo, 1992). These findings highlight the importance of integrated pest management (IPM) strategies that incorporate ecological approaches rather than relying solely on chemical control.

Another critical aspect in pest management is the establishment of economic thresholds, which define the pest population level at which control measures should be implemented to prevent economic losses. For mirid bugs in cocoa, previous studies have suggested that even relatively low population densities can lead to significant damage, particularly during the early stages of pod development (Entwistle, 1972; Sadori et al., 2023; Jumar, 2000). However, economic threshold levels may vary depending on local environmental conditions, crop management practices, and pest pressure, emphasizing the need for site-specific data.

Several studies have investigated Helopeltis spp. abundance and infestation levels across different cocoa-growing regions. For example, Yuspan (2022) reported relatively low population densities in Buol Regency, with infestation intensity ranging from 23.8% to 26.6%. Similarly, Amanda (2020) documented variations in pest abundance and infestation levels in Dharmasraya Regency, where infestation rates ranged from 70.36% to 81.43%. These studies indicate that pest population dynamics can vary significantly across locations due to differences in agroecological conditions and management practices.

Despite these findings, quantitative data on the population abundance, spatial distribution, and infestation intensity of *H. theivora* in Lima Puluh Kota Regency remain limited. This lack of localized information constrains the development of effective and site-specific pest management strategies. Given the economic importance of cocoa and the significant yield losses associated with mirid infestations, there is a critical need to generate empirical data on pest population dynamics and damage levels in this region.

Therefore, this study aimed to (1) determine the abundance of *Helopeltis theivora* populations in cocoa plantations, (2) assess the percentage and intensity of fruit damage caused by this pest, and (3) analyze the variation of infestation levels across different agroecosystem conditions in Lima Puluh Kota Regency, West Sumatra Province. The findings of this study are expected to provide a scientific basis for developing sustainable pest management strategies and improving cocoa productivity in the region.

METHODS

1. Study Area and Experimental Design

This study was conducted in cocoa plantations in Lima Puluh Kota Regency, West Sumatra, Indonesia, on 2023, covering the main fruiting season. The study employed a purposive sampling approach followed by random plant selection, in which plantation sites were first selected based on predefined criteria, and individual sample plants were randomly selected within each site.

Three sub-districts with significant cocoa production were selected, namely Akabiluru, Guguak, and Payakumbuh. In each sub-district, two plantations (≥0.5 ha each) were selected, resulting in six study plots (replications) across six villages. Each plot was treated as an independent experimental unit, while individual cocoa trees served as observational units.

2. Sampling Procedure

Within each plot, sample plants were selected using a systematic diagonal (X-shaped) sampling method to ensure spatial representation. Approximately 10% of the total plant population per plot was sampled; however, to standardize sampling effort, a minimum of 30 trees per plot was observed. Sample trees were selected at regular intervals (two-tree spacing) along the diagonal transects and permanently labeled for repeated observations.

Field observations were conducted four times at weekly intervals, during both morning (08:00–10:00) and afternoon (16:00–18:00) periods to capture variations in insect activity. The total number of observed plants across all plots was 180 trees (30 trees × 6 plots).

3. Data Collection

Abundance of *Helopeltis theivora*

The abundance of *Helopeltis theivora* was assessed using two complementary methods:

1. Chemical knockdown method: A contact insecticide containing deltamethrin (25 EC) was applied at 2 mL L^{-1} using a hand sprayer. Each sample tree was sprayed uniformly, and dislodged insects were collected using a white cloth placed beneath the canopy. Insects were collected approximately 10–15 minutes after application.
2. Hand collection method: Visible insects (nymphs and adults) were manually collected using clear plastic bags and a soft brush.

Collected insects were counted and categorized into life stages (nymphs and adults). Abundance was expressed as (i) total individuals per plot, (ii) number of individuals per life stage, and (iii) number of individuals per stem.

Percentage of Infested Fruit

The percentage of fruit infestation was determined by counting the total number of fruits (B) and the number of infested fruits (A) on each sample tree. Infestation percentage was calculated as:

$$P = A/B \times 100$$

P = Percentage of infested fruits (%),

A = Number of infested fruits,

B = Total number of observed fruits.

Infestation Intensity

Infestation intensity was assessed using a scoring system based on visible damage symptoms on cocoa pods. The intensity of infestation was calculated using the following formula:

$$I = \frac{\Sigma(ni\ x\ si)}{N\ x\ S}\ x\ 100$$

I = infestation intensity (%)

ni = number of fruits at damage scale i

si = damage scale value

N = total number of fruits observed

S = maximum damage scale

4. **Data Analysis**

Data were analyzed using descriptive statistics and expressed as mean ± standard deviation (SD). Differences in abundance and infestation levels among locations were evaluated using one-way analysis of variance (ANOVA), followed by the Least Significant Difference (LSD) test at a 5% significance level, where applicable. All statistical analyses were performed to determine spatial variation in pest abundance and infestation intensity across study sites.

RESULTS AND DISCUSSION

Description of the Agroecosystem

The study was conducted in 3 sub-districts in Lima Puluh Kota Regency. The sub-districts and respective villages selected as study sites were: Akabiluru Sub-district (Suayan Village and Sungai Belantik Village), Guguak Sub-district (Sungai Talang Village and Guguak VIII Koto Village), and Payakumbuh Sub-district (Koto Baru Simalanggang Village and Piobang Village). All sample plots covered approximately 0.5 ha each, with crop ages ranging from 8 to 15 years and an average planting spacing of 3 m × 3 m. Farmers in the study areas cultivate cocoa using a polyculture system, growing various other crops such as coconut, betel nut, banana, mangosteen, avocado, and rambutan. The polyculture system offers several benefits, including opportunities for farmers to earn additional income.

Regarding fertilization, some plots are fertilized, with application intervals varying (every 3 months, every 6 months, and once a year). In contrast, others are not fertilized due to the relatively high cost of fertilizer, resulting in suboptimal fertilization of the cocoa plants. Farmers do not uniformly practice pruning; some plots are pruned regularly, while others are not.

Harvesting is conducted irregularly to avoid squirrel pests, though some plots are harvested regularly. Sanitation is performed routinely to remove fruits infested with pests and diseases, and all plots are sanitized at varying intervals (twice a month, once a month, or once every two months). Some farmers manage their cocoa plantations using basic knowledge passed down from previous generations. In contrast, others acquire knowledge from training sessions provided by Field Extension Officers (PPL) or from the Company (Table 1).

Morphology of the Fruit-Sucking Mirid bug (Helopeltis theivora L.*)*

The mirid bug species observed in the field was *Helopeltis theivora* L., at the nymph and adult stages, which were subsequently collected. The nymphs consisted of first- and second-instar nymphs. The first- and second-instar nymphs had nearly identical shapes. The first-instar nymphs are predominantly reddish-brown and translucent, tending toward transparency (Figure 1a). Second-instar nymphs begin to show wing buds; some are reddish-brown, and others are light green, and on the dorsal side, there are upright, needle-like projections (Figure 1.b).

Table 1. Conditions of the cocoa plantation land

	Akabiluru Subdistrict		Guguak Subdistrict		Payakumbuh Subdistrict	
Observation Variables	Suayan Village	Sungai Belantik Village	Sungai Talang Village	Guguak VIII Koto Village	Koto Baru Village	Piobang Village
Plant Age	10 years	15 years	8 years	12 year	12 year	13 year
Planting Distance	3.5 x 3.5 m	3 x 3 m	3 x 3 m	3 x 3 m	3 x 3 m	3 x 3 m
Crop System	Mixed cropping (coconut)	Polyculture (banana, coconut)	Mixed cropping (coconut, mangosteen, avocado, rambutan)	Polyculture (coconut)	Mixed cropping (coconut)	Mixed cropping (coconut and areca nut)
Fertilization	No fertilization	No fertilization	Once every 6 months	Once a year	Once a year	No fertilization
Harvest	Irregular	Irregular	Regular	Regular	Irregular	Irregular
Pruning	Once a year	Once a year	Twice a year	Not done	Once a year	Not Performed
Sanitation	Once a month	Every two months	Twice a month	Once every two months	Once a month	Every two months

The adults obtained were males and females, measuring 10-12 mm. The male adult's body is smaller and slimmer compared to the female adult's. The female adult's body is larger and more rounded; the male's body is predominantly black with white markings on the posterior section (Figure 1.c), while the female's abdomen is wider in the middle, and the thorax is orange. The tip of the female's abdomen is black (Figure 1.d). Adult insects have a body length of approximately 7–9 mm and a width of 2 mm, with very long legs and antennae. Their body colors vary, including black, red, orange, yellow, and green. Adult female insects can produce between 30 and 60 eggs during their lifetime (Atmadja, 2003).

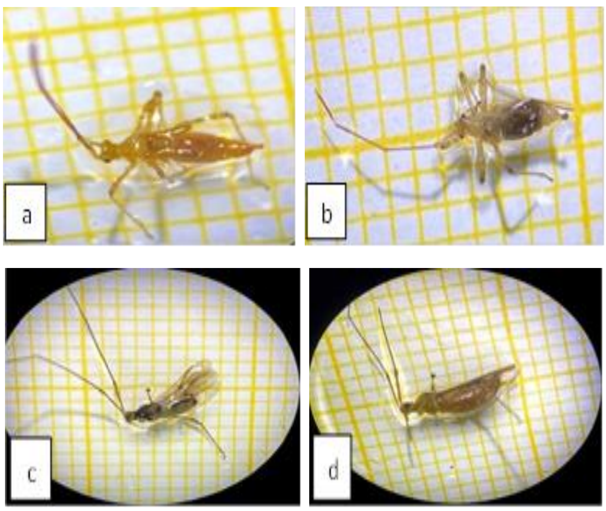

Figure 1. Fruit-sucking mirid bug. a) first-instar nymph, b) second-instar nymph, c) adult male, and d) adult female

Abundance of Fruit-Feeding Mirid bugs

A total of 206 fruit-feeding mirid bugs were collected in this study. The number of mirid bugs found in this study varied across research locations. The abundance of the fruit-sucking mirid bug pests collected, in order, was as follows: Nagari Piobang had the highest number of collected pests at 44 individuals, likely because peeled fruit was left near the trees, providing a nesting site for the pests; next was Nagari Suayan with 41 individuals, Nagari Sungai Belantik with 37 individuals, Koto Baru Simalanggang with 35 individuals, Guguak VIII Koto with 34 individuals, and Sungai Talang with 15 individuals—the village with the lowest number of collected pests—because the fields in Sungai Talang were sprayed with an insecticide containing the active ingredient lambda-cyhalothrin by farmers (Table 2).

Table 2. Abundance of the Fruit-Sucking Mirid bug (*Helopeltis theivora* L.) at several study sites

Location	Observation Time				Number
	PM1	PM2	PM3	PM4	
Suayan	12	10	8	11	41 ± 1.71%
Belantik River	10	11	8	8	37 ± 1.5%
Talang River	2	2	4	7	15 ± 2.36%
Guguak VIII Koto	7	11	7	9	34 ± 1.91%
Koto Baru	9	10	8	8	35 ± 0.96%
Piobang	11	14	10	9	44 ± 2.16%
Total	51	58	45	52	206 ± 5.32%

The number of cocoa fruit-feeding mirid bugs collected was relatively low; their abundance is influenced by climatic factors and food availability (Table 2). During field observations, temperatures at the study site ranged from 26 to 32°C, and rainfall was infrequent. Infestations of this pest are common during the rainy season and decrease during the dry season. Food availability also influences the development of cocoa fruit-feeding mirid bugs. According to Jumar (2000), food serves as the nutritional source on which insects rely for survival and growth; if food is available in sufficient quantity and quality, insect populations will increase rapidly, whereas if food conditions are inadequate, insect populations will decline. Regarding field sampling, farmers had already harvested the fruit and cleared the fields, thereby reducing food availability. Additionally, the condition of mature cocoa beans and stems also influences the development of cocoa bean-sucking beetles.

Table 3. Abundance of Cocoa Fruit-Sucking Mirid Bugs by Life Stage

Location	Stadiums		Number
	Nymph	Adult	
Suayan	27	14	41 ± 9.19%
Belantik River	24	13	37 ± 7.78%
Talang River	11	4	15 ± 4.95%
Guguak VIII Koto	20	14	34 ± 4.24%
Koto Baru	23	12	35 ± 7.78%
Piobang	26	18	44 ± 5.66%
Total	131	75	206 ± 39.59%

The population abundance of cocoa fruit-sucking mirid bugs at the nymphal stage was higher than at the adult stage (Table 3). This difference in pest population abundance is related to the collection method and observation time. Nymphs are easier to collect by hand (hand collecting), whereas adult stages are less common because, in the adult phase, they already have wings, making them prone to flying away during collection; additionally, when the pest has been frequently controlled, it becomes more sensitive.

The Chemical Knock Down collection method using the insecticide with the active ingredient deltamethrin 25EC is less effective for capturing pests, as this insecticide is a stomach poison and therefore takes time to take effect; however, it is effective at killing pests, although the application process takes approximately 15 minutes. Chowdhury et al. (2013) reported that the active ingredients suitable for controlling cocoa fruit-sucking stink bugs include Quinalfos-cypermethrin, Thiamethoxam, and Lambda-cyhalothrin, which are effective against the cocoa fruit-sucking stink bug (*Helopeltis theivora* L.). This implies that the active ingredients used to control the abundance of cocoa fruit-sucking stink bugs are less effective.

The average number of fruit-feeding mirid bugs per stem ranged from 0.05 to 0.35 individuals per stem (Table 4). This means there were fewer than 1 individual per cocoa stem. The abundance of cocoa fruit-feeding mirid bugs in Lima Puluh Kota Regency was relatively low because sampling was conducted at times that did not align with their activity patterns. In this study, sampling was conducted in the morning and afternoon. In contrast, according to Hall (1949), the most effective times for spraying and sampling are in the late afternoon to evening, from 6:00 PM to 10:00 PM WIB, as the movement of cocoa fruit-feeding mirid bugs is slow or completely stationary during those hours.

Table 4. Abundance of Cocoa Fruit-Sucking Beetles based on the number of individuals per stem.

Location	Observation Time				Number
	PM1	PM2	PM3	PM4	
Suayan	0.3	0.25	0.2	0.27	1.02 ± 4.20%
Belantik River	0.25	0.27	0.1	0.2	0.82 ± 7.59%
Talang River	0.05	0.05	0.1	0.17	0.37 ± 5.68%
Guguak VIII Koto	0.17	0.27	0.17	0.22	0.83 ± 4.79%
Koto Baru	0.22	0.25	0.2	0.2	0.87 ± 2.36%
Piobang	0.27	0.35	0.25	0.22	1.09 ± 5.56%

Percentage of Infested Fruit

The percentage of fruit damage caused by cocoa fruit-sucking beetles varied across each study location. The highest percentage was recorded in Nagari Piobang at 51.76%. This high percentage is attributed to poor sanitation and maintenance of cocoa plantations, including the absence of pruning and failure to remove fallen leaves and debris. Consequently, cocoa plants grow tall, and proper land maintenance—including the removal of cocoa husks left near the stems—is neglected, allowing them to serve as nesting sites or food reserves for pests, which is why the fruit-sucking stink bug, which was collected, was found in large numbers at this location. Meanwhile, the lowest percentage was recorded in Sungai Talang Village at 35.89%. This is due to farm-owner maintenance, including sanitation, spraying, and pruning (Table 5).

Table 5. Percentage of Plant Damage

Subdistrict	Village	Percentage of Infected Fruit (%)
Akabiluru	Suayan	48.31% ± 2.92%
	Sungai Belantik	49.68% ± 2.79%
Guguak	Talang River	35.89% ± 5.52%
	Guguak VIII Koto	39.07% ± 2.13%
Payakumbuh	Koto Baru	37.79% ± 5.51%
	Piobang	51.76% ± 2.45%

The highest crop damage percentage was in Nagari Piobang, at 51.76%, and the lowest was in Nagari Sungai Talang, at 35.89%. The percentage of infested fruit at the study site was relatively low because there were still a large number of natural enemies acting as predators for the cocoa leaf beetle, such as black ants (*Dolichoderus thoracicus*), weaver ants (*Oecophylla smaragdina*), and spiders (*Araneae*) (Figure 2). According to Wijngarden (2007), the intensity of fruit damage caused by attacks from cocoa fruit-sucking bugs is significantly lower on cocoa trees with abundant ants compared to trees without ants. The presence of these natural enemies can reduce the population of cocoa fruit-sucking bugs on the plants. According to Siswanto and Karmawati (2012), black ants (*Dolichoderus thoracicus*), weaver ants (*Oecophylla smaragdina*), and spiders (*Araneae*) are natural predators of the cocoa fruit-sucking beetle.

Intensity of Cocoa Fruit-Sucking Beetle Infestations

Attacks by these fruit-sucking stink bugs cause significant losses for farmers and are the primary pest of cocoa plants after *Conopomorpha cramerella*. When these pests attack small fruits, they have a severe impact, as they can cause crop failure; when they attack larger fruits, they cause black spots to form on the fruit surface. Data on the intensity of attacks on cocoa fruits was collected during harvest by randomly selecting 50 fruits for examination.

Figure 2. Natural enemies of the cocoa fruit-sucking beetle. a) black ants, b) weaver ants, and c) spiders

The intensity of cocoa fruit attacks varied across the studied Nagaris, with the highest at Nagari Piobang (41.13%) and the lowest at Nagari Sungai Talang (31.88%). Sungai Talang Nagari had the lowest intensity because the plantations were well-maintained and the land was clean; farmers harvested weekly, cleaned the cocoa plants, and sprayed pesticides monthly (Table 6).

Table 6. Cocoa Fruit Infestation Intensity

Subdistrict	Village	Infestation Intensity (%)
Akabiluru	Suayan	40.38% ± 1.89%
	Belantik River	39.75% ± 2.53%
Guguak	Talang River	31.88% ± 3.42%
	Guguak VIII Koto	37.13% ± 1.25%
Payakumbuh	Koto Baru	36.38% ± 1.11%
	Piobang	41.13% ± 1.70%

Grishelda (2016) reported that the damage intensity caused by *Helopeltis* sp. in Agam Regency was 24.78%–26.65%; this damage was lower than that in Lima Puluh Kota Regency, where farmers had implemented sanitation, intensive cocoa plant management, and control measures against the cocoa fruit-sucking beetle. In contrast, in the "area of Lima Puluh Kota Regency, some plantations were clean during the study, while others were dirty and poorly maintained. Therefore, farmers in Lima Puluh Kota Regency need to implement sanitation, intensive care of cocoa plants, and control of the cocoa fruit-sucking bug to reduce the intensity of cocoa fruit attacks.

CONCLUSIONS

This study demonstrates that *Helopeltis theivora* population abundance and infestation intensity vary across cocoa plantations in Lima Puluh Kota Regency. A total of 206 individuals were recorded, with nymphs accounting for the majority of the population. Pest density ranged from 0.05 to 0.35 individuals per stem, indicating relatively low abundance.

Infestation levels were highest in Piobang Village and lowest in Sungai Talang Village, reflecting differences in farm management practices. Poor sanitation and lack of maintenance were associated with higher infestation, while well-managed plantations showed reduced pest pressure.

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REFERENCES

Anggraini, F. (2012). *Kepadatan Hama Kepik Penghisap Buah (Helopeltis* sp.*) yang Ditemukan pada Tanaman Kakao di Daerah Lubang Panjang Kecamatan Baringin Kota Sawah Lunto.* STKIP PGRI Sumatera Barat.

Amanda, V. F. (2020). Kelimpahan Populasi *Helopeltis* sp. dan Tingkat Kerusakan Buah Kakao di Kecamatan Sitiung Kabupaten Dharmasraya. *Jurnal ilmu-ilmu pertanian* (14) :33-46.

Atmadja, W. R. (2003). Status Helopeltis Antomi Sebagai Hama pada Beberapa Tanaman Perkebunan dan Pengendaliannya. *Jurnal Litbang Pertanian*, 22(2), 57-63.

[BPS] Badan Pusat Statistik Provinsi Sumatera Barat. (2023). Sumatera Barat Dalam Angka 2023. Badan Pusat Statistik Provinsi Sumatera Barat, Padang.

Cempaka, Gita. (2015). *Identifikasi Jenis Dan Inang Kepik Helopeltis Didaerah Bogor Dan Cianjur.* Fakultas Pertanian, Institut Pertanian Bogor. Bogor.

Chowdhury, R. A. M, Mamun, M.S.A., & Paul, S.K. (2013). Relative efficacy of some insecticides for the control of tea mosquito bug, *Helopeltis theivora* (Waterhouse) in Bangladesh. *Journal of Plant Protection Science* 5(1):Lima Puluh-54.

[Ditjenbun] Direktorat Jenderal Perkebunan. (2021). *Statistik Perkebunan Indonesia.* Sekretariat Direktorat Jendral Perkebunan.

Esrita. (2007). *Bertanam Coklat*. Majalah Trubus : 200 : 10 – 13 : Yogyakarta.

Grishelda. 2016. *Tingkat Serangan Kepik Penghisap Buah Kakao (Helopeltis* spp. [Hemiptera, Miridae*]) Pada Tanaman Kakao (Theobroma Cacao* L.*) Crollo dan Forestero di Kabupaten Agam*. Padang: Universitas Andalas.

Hall, C.JJ.V. (1949). *Kakao*. Lembaga Pendidikan Perkebunan.Yogyakarta.

Heviyanti, M. & Syahril, M. (2018). Keanekaragaman dan Kelimpahan Serangga Hama dan Predator pada Tanaman Padi (*Oryza sativa*) di Desa Paya Rahat, Kabupaten Aceh Tamiang. *Agrosamudra*, 5(2), pp.31–38.

[ICCO] International Cocoa Organization (2016) Overview of cocoa supply and demand. In ICCO Cocoa Market Outlook Conference. London.

Ikhsan, Z., Ikhlas, M. A., Hamid, H., & Dandy, A. O. (2024). Level of pest infestation on cocoa (Theobroma cacao l.) variety BL-50 in tanah datar regency, west sumatera province, Indonesia. *Andalasian International Journal of Entomology Учредители: Universitas Andalas*, *2*(1), 38-47.

Indriani, D. P. (2004). *Strategi Pengolahan Perkebunan Kakao Dalam Mengatasi Serangan Helopeltis antomi Menuju Agroekosistem Kakao Berkelanjutan di Afdeling Rajamandaka PTPN VIII Jawa Barat.* Sekolah Pascasarjana Institut Pertanian Bogor.

Indriati, G., Soesanthy, F., & Hapsari, A. D. (2014). Pengendalian *Helopeltis* spp. (Hemiptera: Miridae) pada Tanaman Kakao Mendukung Pertanian Terpadu Ramah Lingkungan. Bunga Rampai: *Inovasi Teknologi Bioindustri Kakao*. 1: 179–188.

Jalgaonkar, V. N., Gawankar, M.S., Bendale, V.W., & Patil P.D. (2009). Efficacy of Some Insecticides Against Cashew Tea Mosquito bug *Helopeltis antonii* Sign. *The Journal of Plant Protection Sciences* 1 (1):96-97.

Janekovi, F., & Novak T. (2012). PCA-A Powerful Method for Analyze Ecological Niches. Principal Component Analysis - Multidisciplinary Applications.

Jumar. (2000). *Entomologi Pertanian*. Jakarta: Rineka Cipta.

Kresnawati I., A. Budiani, A. Wahab, & T. W. Darmono. (2010). Aplikasi biokaolin untuk perlindungan buah kakao dari serangan PBK, *Helopeltis* Sp. dan *Phytophthora palmivora*. *Menara Perkebunan*, 78(1): 25-31.

Mahdona N. (2009). *Tingkat Serangan Hama Kepik Pengisap Buah (Helopeltis* Sp.) *(Hemiptera : Miridae) pada Tanaman Kakao (Theobroma Cacao* L.*) di Dataran Rendah dan Tinggi di Sumatera Barat*. Padang: Universitas Andalas.

Puspita, Ratna., Hidayat, Kadarisman., & Yulianto, Edy. 2015. Pengaruh Produksi Kakao Domestik, Harga Kakao Internasional, dan Nilai Tukar Terhadap Ekspor Kakao Indonesia ke Amerika Serikat. Malang: Universitas Brawijaya. Vol. 27, No. 1, Oktober 2015.Samudra. (2005). Tanaman Kakao Budidaya dan Pengolahan Hasil. Yogyakarta : Kanisius.

Sadori, T., Ikhsan, Z., & Yaherwandi, Y. (2023). Efektivitas Pengendalian Serangan Penggerek Buah Kakao (Conopomorpha cramerella Snellen) dengan Metode Kondomisasi. *Jurnal Agrotek Lestari*, *9*(1), 57-68.

Siswanto, Muhamad, R., Omar, D., & Karmawati, E. (2009). The effect of mating on the eggsfertilitiy and fecundity of Helopeltis antonii (Heteroptera: Miridae). *Tropical Life Sciences Research,* 20(1), 89-97.

Siswanto & E. Karmawati. (2012). Pengendalian Hama Utama Kakao dengan Pestisida Nabati Agen Hayati.Bogor. *Jurnal Pusat Penelitian dan Pengembangan Perkebunan.* Vol. 11 (2): 99-103.

Sulistyowati, E., Wahyudi, T., Panggabean, & Pujiyanto. (2008). Pengendalian Hama. dalam Panduan Lengkap Kakao Manajemen Agribisnis dari Hulu hingga Hilir. Jakarta. Penebar Swadaya.

Wiryadiputra, S. (2007). Pengelolaan Hama Terpadu pada Hama Penggerek Buah Kopi, *Hypothenemus hampei* (Ferr) Penggunaan Perangkap Brocap Trap. Jember, Jawa Timur: Pusat Penelitian Kopi dan Kakao Indonesia.

Yuspan. (2022) Kepadatan Populasi dan Intensitas Serangan Hama Kepik Penghisap Buah Kakao (*Helopeltis* sp.) pada Tanaman Kakao (*Theobroma cacao* L.) di Desa Lonu, Kecamatan Bunobogi, Kabupaten Buol. *E-Jurnal ilmu pertanian* (3) :183-191.