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Diversity and abundance of insects in crystal guava plants (*Psidium guajava* L.) in North Sumatra, Indonesia

Pasu Maria Br Sinurat[1], B. Manurung[1]* and Abdul Hakim Daulae[1]

[1] Biology Study Program, Faculty of Mathematics and Natural Sciences, State University of Medan, Jl. Willem Iskandar Psr. V, Medan Estate, Medan, Indonesia

Correspondence Author: B. Manurung

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Abstract

This study aims to determine the types of insects and the level of diversity, dominance, frequency of presence and evenness of insects on crystal guava plants in Hamlet I, Suka Makmur Village, Kutalimbaru District. This study aims to determine the types of insects and the level of diversity, dominance, frequency of presence and evenness of insects on crystal guava plants in Hamlet I, Suka Makmur Village, Kutalimbaru District. This study was conducted from April to May 2025 using yellow sticky traps (stationary) with four replications. The results showed that there were 28 insect species, 21 families and 8 orders with *Bactrocera dorsalis* and *Bactrocera carambolae* being the most abundant species. The insect diversity index was low (H' = 0.93). The dominance index was in the high category (C = 0.644). The frequency of presence was in the rare category (FP = 49.29%). The evenness index was in the low category (E = 0.2791). This study indicates an imbalance in the ecosystem because although the number of species is quite high, the distribution of the number of individuals between species is very uneven. The low H' value in this study indicates the need for habitat management and control of dominant species to create a more balanced and stable insect community and create environmental conditions that better support insect diversity and reduce pest dominance.

Keywords: Insects, Diversity, Dominance, Frequency of Presence, Evenness

1. Introduction

Crystal guava (*Psidium guajava* L.) is one of the horticultural products that is currently more widely known and favoured in several tropical countries. This horticultural product has many advantages, among which are superior with a fresh and sweet taste, as well as a crunchy texture, has thick flesh and is almost seedless (Rustani & Susanto, 2019) [14]. Crystal guava is also included in the guava group. This crystal guava lives in the tropics and in sub-tropical areas so that this crystal guava plant is widely cultivated in various countries including one of them in Indonesia. This crystal guava plant was also developed in Taiwan in 1991. In Indonesia, this plant was only developed in 2009 (Hartati *et al*., 2023) [5].

Crystal guava also has many health benefits, as it contains four times more vitamin C than citrus fruits, vitamin A, vitamin B, magnesium, potassium, and antioxidants. The Ministry of Agriculture supports the preservation of crystal guava because of its simple maintenance and can always bear fruit throughout the year (Hanik *et al*., 2023) [4]. Crystal guava is in demand by farmers because it can produce fruit throughout the year so that harvesting can be arranged by farmers and also the selling price is higher with a good taste than other types of guava (Ramdhona *et al*., 2019) [13].

Insect or insect is the most dominant animal species among other animal species in the phylum of arthropods. Insects play an important role in the human scope, namely as a component of food web biodiversity, namely herbivores, carnivores, corrosive organisms (Lubis *et al*., 2022) [8]. Insects can also function as bioindicators to determine ecosystem health. In addition to knowing the health condition of an ecosystem, insects are also very much found in horticultural crops that have not been studied, one of which is crystal guava (*Psidium guajava* L.).

Insects are useful in maintaining the balance of natural ecosystems because there are many insects in a location that can also be used as indicators of biodiversity, ecosystem health, degradation and landscape in the ecosystem insects also have an important role, namely as decomposers, predators, parasitoids or natural enemies and pests (Elisabeth *et al*., 2021) [2].

The abundance of each insect has a different trend in an agroecosystem related to reproductive power and adaptation to the appropriate agroecosystem (Tiara, 2023) [16]. The abundance of each type of insect is influenced by factors that determine how many types and populations of these insects (Yudiawati *et al*., 2022) [18]. Insects also play a very important role in agricultural agroecosystems and have beneficial and harmful roles (Nurfuadianti *et al*., 2023) [10]. In Suka Makmur village, Kutalimbaru sub-district and surrounding areas, insect pests cause a lot of damage to crystal guava plants. A personal interview with a community member who owns a commercial crystal guava plantation with an area of 1 ha (10,000m2), revealed that the productivity of his guava plantation has decreased due to insect pests. Until now, there is no information about the types of insects that attack crystal guava in Suka Makmur Village, Kutalimbaru Sub-district. Likewise, the abundance of insect populations and the damage they cause, there is no official report that illustrates the importance of insects as a limiting factor in fruit production in Suka Makmur Village, Kutalimbaru Sub district. Information on species, population abundance is needed, so that the community can use it as a reference for pest control measures.

2. Research methods

This research was conducted on crystal guava plants with an area of 1 hectare located in Dusun I, Suka Makmur Village, Kutalimbaru Subdistrict as a place for insect sampling. Furthermore, the Biology Laboratory of Medan State University as a place to identify insect samples. This research was conducted from April to May 2025.

The tools used to conduct this research are sample bottles, 1.5 L plastic bottles, mobile phone cameras, brushes, label paper, stationery, tweezers, anemometer, hygrometer, thermometer and stereo microscope. The materials used to conduct this research were glumon glue, ethylene and 70% alcohol.

The insect sampling technique in the field uses the "purposive sampling" method, which means that sampling is done deliberately based on certain conditions. Sampling was carried out using a "yellow sticky trap".

The research procedure is:

- Sampling is done using a random method or random sampling. Where all traps are placed randomly at 5 observation points that have been determined by belt transects.
- Traps were made from 1.5 L plastic bottles and smeared with "Glumon" adhesive glue evenly on the surface and hung on plant branches.
- Installation of traps was carried out once every 2 weeks with the traps left for 1x24 hours at 08.00 am - 08.00 am the next day.
- Insects that have entered the trap "yellow sticky trap" will be taken by shedding using ethylene then taken with tweezers and then put into a sample bottle and will be soaked using 70% alcohol, then further identified at the Biology Laboratory of Medan State University using the help of a microscope and identified by looking at morphological characteristics using the key book of insect determination Subyanto and Sulthoni (1991), Borror (1992) [1],

3. Data analysis techniques

a) Insect diversity

Diversity is determined by the number of species and the evenness of the abundance of individuals of each species obtained. The higher the diversity value, the more species obtained, and this value is highly dependent on the total value of individuals of each species or genera. The abundance of individuals of each species obtained, calculated the value of the Shannon-Wienner diversity index (Manurung, 2020) [9] with the following formula:

$$\mathrm{H}' = -\sum_{i=1}^{s} pi\ ln\ pi\ ; pi = \frac{ni}{N}$$

Description

H' = Shannon-Wiener species diversity index;
Pi = ni / N;
Pi = Number of individuals - i (number of 1 species);
Ni = Number of individuals of type i; and
N = Total number of individuals of all types.

In knowing the existence of diversity values, the Shannon-Winner index is categorized into three criteria, namely:

H´ < 1 = Low diversity
1 < H´ > = Medium diversity
H´ > 3 = High diversity

b) Dominance index

The dominance index (C) is used to calculate the dominance of certain species in a community. To measure the dominance of insects, the dominance index can be calculated (Manurung, 2020) [9] as follows:

$$C = \sum \left(\frac{ni}{N}\right)^2$$

Description

D = Dominance Index
Pi = ni/N
Ni = Number of Individual ke-i
N = Total number of individuals

c) Frequency of presence

Insect presence frequency is an insect that shows the number of times a particular insect is found in the habitat of each observation (Ihfitasari *et al*., 2019) [7]:

$$FP = \frac{Number\ of\ places\ where\ insect\ species\ are\ found}{Total\ number\ of\ places} \times 100\%$$

Description

0 - 25% = Very rare
26 - 50% = Rare
51 - 75% = Often
>76% = Very often

d) Evennes index

The evenness index was calculated using the Evenness index formula Manurung (2020) [9]:

E = H´ / In S

Description

E = Type uniformity index
H´ = Shannon-Wienner Diversity Index
Ln = Natural logarithm
S = All types

4. Research result

a) Types and number of insects on crystal guava plants

The types and numbers of insects found in the crystal guava plant area in Dusun I, Suka Makmur Village, Kutalimbaru Subdistrict from April to June 2025 obtained 1.255 individuals consisting of 28 species belonging to 21 families. The types and number of insect individuals found on Crystal Guava Plants in Dusun I, Suka Makmur Village, Kutalimbaru Subdistrict are presented in Table 4.1.

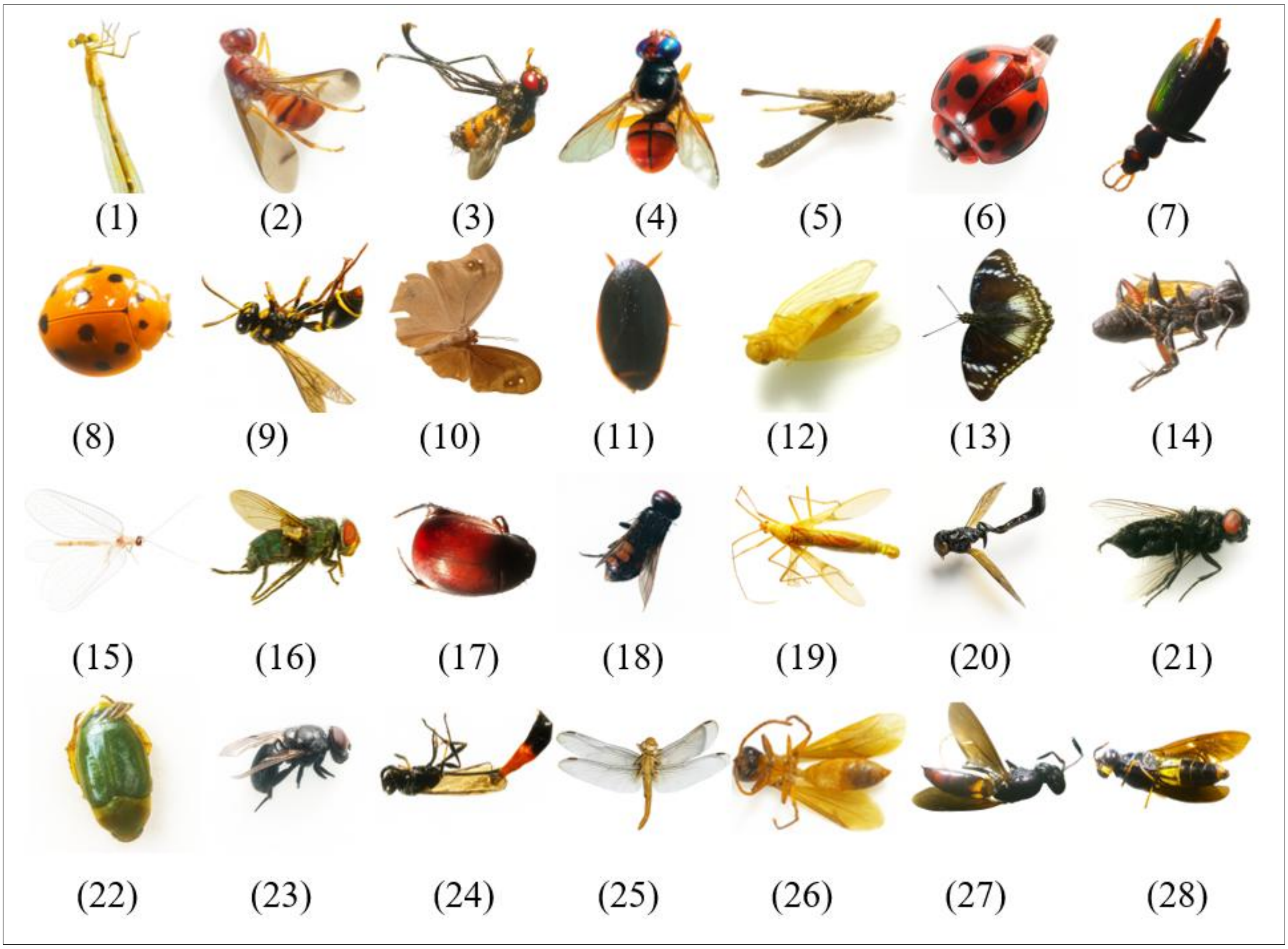

Fig 1(a): (1) = *Agriocnemis splendidissima*, (2) = *Bactrocera carambolae*, (3) = *Cholomyia inaequipes*, (4) = *Bactrocera dorsalis*, (5) = *Chorthippus biguttulus*, (6) = *Coleophora inaequalis*, (7) = *Coptodera aerate*, (8) = *Epilachna admirabilis*, (9) = *Eumenes coarctatus*, (10) = *Euphyes vestris*, (11) = *Graphoderus liberus*, (12) = *Haplaxius ovatus*, (13) = *Hypolimnas bolina*, (14) = *Ichneumon albiger*, (15) = *Leucochrysa pavida*, (16) = *Lucilia sericata*, (17) = *Maladera castanea*, (18) = *Musa domestica*, (19) = *Nephrotoma scurra*, (20) = *Ocyptamus fuscipennis*, (21) = *Phaonia lugubris*, (22) = *Phyllophaga crinite*, (23) = *Pollenia angustigena*, (24) = *Probolus culpatorius*, (25) = *Sympetrum costiferum*, (26) = *Tricarinodynerus guerinii*, (27) = *Vespa affinis*, (28) = *Vespa velutina*

Table 4.1

No	ORDO	Family	Species	Number of Individuals					Σ
				1	2	3	4	5	
1	Coleoptera	1. Coccinellidae	*Coleophora inaequalis*	1	1	0	0	0	2
			Epilachna admirabilis	0	0	1	0	0	1
		2. Carabidae	*Coptodera aerate*	1	0	0	1	0	2
		3. Dytiscidae	*Graphoderus liberus*	0	0	0	1	0	1
		4. Scarabaeidae	*Maladera castanea*	1	1	0	0	0	2
			Phyllophaga crinite	0	0	0	0	1	1
2	Diptera	1. Calliphoridae	*Lucilia sericata*	2	2	0	0	0	4
		2. Muscidae	*Musca domestica*	1	7	1	3	0	12
			Phaonia lugubris	11	11	9	19	4	54
		3. Polleniidae	*Pollenia angustigena*	2	1	2	3	1	9
		4. Syrphidae	*Ocyptamus fuscipennis*	1	0	0	0	0	1
		5. Tachinidae	*Cholomyia inaequipes*	1	3	0	0	0	4
		6. Tephritidae	*Bactrocera carambolae*	13	38	16	20	16	103
			Bactrocera dorsalis	246	236	170	174	174	1000
		7. Tipulidae	*Nephrotoma scurra*	0	1	0	0	0	1
3	Hemiptera	1. Cixiidae	*Haplaxius ovatus*	0	1	0	0	0	1

4	Hymenoptera	1. Eumenidae	*Tricarinodynerus guerinii*	1	1	1	4	4	11
		2. Ichneumonidae	*Ichneumon albiger*	1	0	1	0	1	3
			Probolus culpatorius	0	1	0	0	0	1
		3. Vespidae	*Eumenes coarctatus*	0	1	2	1	0	4
			Vespa affinis	0	1	3	1	0	5
			Vespa velutina	1	3	3	3	2	12
5	Lepidoptera	1. Nymphalidae	*Hypolimnas bolina*	1	0	0	0	0	1
		2. Hesperiidae	*Euphyes vestris*	1	0	0	0	0	1
6	Neuroptera	1. Chrysopidae	*Leucochrysa pavida*	5	1	5	1	2	14
7	Odonata	1. Coenagrionidae	*Agriocnemis splendidissima*	1	0	0	0	0	1
		2. Libellulidae	*Sympetrum costiferum*	0	2	0	0	0	2
8.	Orthoptera	1. Acrididae	*Chorthippus biguttulus*	0	0	0	1	0	1
Total				291	312	214	232	206	1255

Based on Table 4.1, the type of insect that is most commonly found in Crystal Guava Plants in Hamlet I, Suka Makmur Village, Kutalimbaru Subdistrict is *Bactrocera dorsalis* with the highest total number of individuals. This shows that Bactrocera dorsalis shows the dominance of certain species that are adaptive and widespread, while most other species rarely appear, which can indicate ecological pressure in the Crystal Guava Plant area.

b) Diversity index of insect species in crystal guava plants

The level of species diversity was analysed using the species diversity index calculated by the Shannon-Wienner method, which refers to the number of individuals of each type found. Information regarding the insect diversity index in crystal guava plants located in Hamlet I, Suka Makmur Village, Kutalimbaru District, is presented in Table 4.2.

Table 4.2

No	Total types of insects	Diversity index (H')
1.	28 Species	0.93

Based on Table 4.2, it can be seen that the diversity index of insect species in Crystal Guava Plants in Hamlet I, Suka Makmur Village, Kutalimbaru District is 0.93. The value of the Shannon-Wiener diversity index (H') obtained is 0.93 which is classified in the low diversity category. In other words, the insect community at the observation site is dominated by one species only, while other species are present in very limited numbers.

c) Dominance index of insect species on crystal guava plants

The dominance index is a data that serves to determine the dominant type of insect species on crystal guava plants in Dusun I, Suka Makmur Village, Kutalimbaru Subdistrict, obtained by Simpson's Dominance Index formula. The dominance index value of insects found in Dusun I, Suka Makmur Village, Kutalimbaru Subdistrict is presented in Table 4.3.

Table 4.3

No	Total types of insects	Dominance index (C)
1.	28 Species	0.644

Based on Table 4.3, the dominance index (C) value is 0.644. This value indicates that the insect community in Crystal Guava Plants in Hamlet I, Suka Makmur Village, Kutalimbaru Subdistrict is very dominated by one or only a few species. The dominance index value ranges from 0 to 1, where getting closer to 1 indicates that only a few species dominate the community, while other species are very small in number.

d) Frequency of insect species presence on crystal guava plants

The frequency of presence was used to obtain information about the most dominating insect species in a community in a predetermined study area. The dominance index value of insects found in the Dusun I area of Suka Makmur Village, Kutalimbaru District, can be seen in Table 4.4.

Table 4.4

No	Total types of insects	Frequency of Presence (FP)
1.	28 Species	49.29%

Based on Table 4.4, shows that the Frequency of Presence (FK) of insect species, obtained a total average value of frequency of presence of 49.29%. Of the 28 species observed, there are several species with very high frequency of presence (100%), such as: *Bactrocera carambolae*, *Bactrocera dorsalis*, *Leucochrysa pavida*, and *Phanoia lugubris*.

e) Evenness index of insect species in crystal guava plants

The species evenness index is used to determine the extent to which the distribution of individuals across species in a community is balanced. The level of evenness of insect species found in crystal guava plants in Hamlet I, Suka Makmur Village, Kutalimbaru District, was obtained through calculations using the Evenness Index formula, and the results are presented in Table 4.5.

Table 4.5

No	Area	Evenness Index (E)
1.	Crystal Guava Plantation	0.2791

Based on Table 4.5 shows the Evenness Index of insect species in the Crystal Guava Plantation area in Dusun I, Suka Makmur Village, Kutalimbaru Subdistrict has an evenness index of

0.2791, which is included in the low category, which indicates that the insect community in the crystal guava land is uneven for the insect community found in the crystal guava plantation in Dusun I, Suka Makmur Village, Kutalimbaru Subdistrict.

f) Environmental factors in hamlet I, Suka Makmur village, Kutalimbaru subdistrict

Environmental factor data is used to describe the environmental conditions at the time the insects were encountered at the time of this study obtained in environmental conditions as in Table 4.6.

Table 4.6

No	Parameter	Value
1.	Temperature (˚C)	30-32
2.	Air Humidity (%)	45-60
3.	Wind Speed (m/s)	1-3

Based on Table 4.6, it can be concluded that these high temperatures are within the optimal range for the physiological activities of tropical insects, such as growth, reproduction, and movement. However, the relatively lower humidity levels (45-60%) may affect some insect groups that require more humid conditions to develop optimally. Low wind speeds (1-3 m/s) favour unimpeded mobility of insects in the cropping area, which is important for pollinators, natural predators and pest species.

5. Discussion

A. Types and number of insects on crystal guava plants

Research on Crystal Guava Plants in Hamlet I of Suka Makmur Village, Kutalimbaru Subdistrict found consisted of 28 species with 1255 individuals, divided into 20 families. Of the total 28 species identified, the order Diptera dominates with the highest number of species and individuals. This can be seen from its two main species, *Bactrocera carambolae* and *Bactrocera dorsalis*, which contributed 103 and 1000 individuals respectively, making *Bactrocera dorsalis* the most abundant species. Besides Diptera, other orders such as Hymenoptera, Coleoptera and Lepidoptera were also recorded, although the number of individuals was much smaller. Some families that were quite prominent in the number of individuals besides Tephritidae were Muscidae, Syrphidae, and Ichneumonidae. The high dominance of certain species, especially Bactrocera dorsalis, may indicate an ecosystem imbalance or the presence of resources that are highly favoured by the species. Relatively high species diversity indicates ecosystem conditions favouring different insect groups, but very high abundance of one or two species indicates potential ecological dominance.

B. Diversity index

Based on the calculation results in the table, the Shannon-Wiener diversity index (H') value for the observed insect community is 0.93 which is categorised as a low level of diversity. This indicates that the structure of the insect community at the study site is very unbalanced and dominated by certain species. The most striking dominance came from the species *Bactrocera dorsalis*, which accounted for approximately 79.68% of the total individuals (1,000 out of 1,255 individuals). This extreme dominance caused the species' Pi ln Pi value to be the highest, 0.408, which contributed greatly to the final diversity index value. In contrast, most other species were only found in very small numbers, with Pi below 0.01 and very low individual H' values. This indicates that the distribution of individuals between species is uneven, which is typical of low diversity communities.

According to the interpretation criteria of the Shannon Wiener index, values below 1.0 indicate that the community is in an unstable condition or under ecological pressure, both in terms of resource availability, environmental disturbance and ecological stress in terms of resource availability, environmental disturbances, and imbalances in interactions between species. According to Fitriana *et al*., (2021) [3] noted that the dominance of the *Bactrocera* genus in fruit farming areas can cause a decrease in diversity because the presence of abundant host fruit encourages a surge in the population of these species. Therefore, the low value of H' in this study indicates the need for habitat management and control of dominant species to create a more balanced and stable insect community.

C. Dominance index

Based on Table 4.3, the dominance value obtained is 0.644, which indicates that this community has a high level of species dominance. In the interpretation of this index, a value close to 1 indicates a strong dominance by one or several specific species, while a value close to 0 indicates a more even distribution of individuals among various species. With a value of 0.644, this means that the insect community in this study is unbalanced and strongly influenced by the presence of one dominant species, *Bactrocera dorsalis*, which alone contributes 0.639 to the total dominance value of almost all dominance values.

According to Fitriana *et al*., (2021) [3], *Bactrocera* often dominates insect communities in fruit farming ecosystems due to the availability of host fruits throughout the season. Similarly, according to Odum (1993) [11], high dominance often occurs in ecosystems that are disturbed or in the early stages of ecological succession, where certain pioneer or adaptive species rapidly dominate the environment. In this context, the high dominance of *Bactrocera dorsalis* could be indicate the presence of ecological pressures, such as pesticide use that suppresses populations of its natural predators or competitors, or habitat changes that favour this species selectively. The high dominance of one species can be an indication of environmental disturbances or ecological pressures that cause only certain species to survive and reproduce in large numbers, while other species are pushed out or unable to compete. Such a situation can have a negative impact on ecosystem stability as low species diversity makes communities more vulnerable to environmental changes or pest and disease attacks.

D. Frequency of presence

Based on the data in Table 4.4 Frequency of Presence of insect species, it is known that only a small part of the species appears consistently at all observation points. There are six species with a 100% frequency of presence, namely *Bactrocera carambolae*, *Bactrocera dorsalis*, *Leucochrysa pavida*, *Phania lugubris*, and several others. This shows that these species are eurytopic, which is able to adapt and survive in various environmental conditions, so they are often found in various observation locations. In contrast, most of the other species showed lower frequencies of presence, between 20% and 60%, indicating that they have limited distribution or specific habitat preferences. This could be influenced by various factors, such as specialised microhabitat requirements, interspecies competition, or environmental pressures. The overall mean frequency of presence was 49.29%, indicating that most species were only present at around half of all observation points. This indicates a moderate to low level of community stability, as stable communities tend to have a high frequency of presence and are evenly distributed across sites.

These results are in line with research by Herlina *et al*., (2020) [6] which shows that species with high frequency of presence values are usually dominant or generalist species, while species with low frequency of presence values tend to be specialists or less able to compete. An even distribution of presence can be an important indicator in assessing ecosystem health, where balanced species diversity and presence reflect a stable and productive ecosystem. Thus, the pattern of insect presence in this study suggests the dominance of a few specific adaptive and widespread species, while most other species are rarely present, which could indicate the presence of disturbance of the ecosystem or stress of the environment in parts of the observation area.

E. Evenness index

Based on table 4.5, the value of evenness in crystal guava plantation is 0.2791. This value indicates that the distribution of individuals between species in the insect community is uneven. The Evenness Index has a range of values between 0 and 1, where values close to 1 indicate that all species have a relatively balanced number of individuals, while values close to 0 indicate that only a few species dominate the population. With an E value of 0.2791, this indicates that the insect population on the land is highly dominated by one or a few species, while most other species have only a few individuals. This imbalance can be seen from the very high dominance by *Bactrocera dorsalis*, as reflected in the previous dominance index (C = 0.644), as well as the low Shannon-Wiener diversity value (H' = 0.93). This gap suggests that the insect community structure in the crystal guava field is still unstable and potentially vulnerable to ecosystem disturbances. Such conditions are often found in intensively cultivated ecosystems or monocultures, which tend to favour the development of certain species that are adaptive to homogeneous environments. Low evenness may indicate ecological pressures, such as the use of pesticides, indicate ecological pressures, such as pesticide use or habitat disturbance, that cause only certain species to survive and reproduce. In addition, communities with low evenness tend to have less functional diversity, potentially decreasing ecosystem resilience to environmental change.

F. Environmental factors affecting insect presence

Based on Table 4.6, it can be seen that the environmental data on the crystal guava plantation, the temperature was recorded in the range of 30-32 °C, the air humidity was between 45-60%, and the wind speed ranged from 1-3 m/s, it can be seen that these conditions are relatively hot with moderate to low humidity levels. These conditions greatly affect the diversity and distribution of insects in an agricultural ecosystem. High temperatures can accelerate the life cycle of insects, especially tropical species such as *Bactrocera dorsalis*, which is known to be very tolerant of hot temperatures and able to develop optimally in the temperature range of 28-32°C. According to previous research by Supartha *et al*., (2023) [15], which showed that the population of *Bactrocera dorsalis* increased significantly at temperatures above 30°C and humidity below 70%. The fairly low humidity (45-60%) in the field tends to be unfavourable for insects that require high humidity to survive and reproduce, such as several species from the Lepidoptera and Neuroptera orders. This contributes to the low evenness index value (E = 0.2791), which shows that insect distribution is uneven and dominated by certain species, especially *Bactrocera dorsalis*. This dominance indicates that the ecosystem in the field is ecologically unbalanced. According to Wahyuni *et al*., (2022) [17], high dominance of pest species usually occurs in monoculture agroecosystems with environmental conditions that are not very supportive of the presence of natural enemies or other insect species that act as predators or pollinators. Therefore, it is important to apply agroecological approaches such as planting refugia plants, integration of shade trees, and increasing crop diversity to create environmental conditions trees, and increasing crop diversity to create environmental conditions that favour insect diversity and reduce pest dominance (Prasetyo and Kurniawan, 2024) [12].

6. Conclusion

The type of insect most commonly found in Crystal Guava Plants in Hamlet I, Suka Makmur Village, Kutalimbaru Subdistrict in April to May 2025 was found to be *Bactrocera dorsalis*. Diversity index of insect species in Crystal Guava Plants in Hamlet I, Suka Makmur Village, Kutalimbaru District is 0.93, including in the low diversity category. Dominance index of insect species in Crystal Guava Plants in Hamlet I of Suka Makmur Village, Kutalimbaru Subdistrict of 0.644 is included in the high dominance category. Frequency of Presence in Crystal Guava Plants in Hamlet I, Suka Makmur Village, Kutalimbaru Subdistrict of 49.29% is included in the category of frequency of presence rarely. Evenness index of insect species in Crystal Guava Plants in Hamlet I, Suka Makmur Village, Kutalimbaru Subdistrict of 0.2791 is included in the category of small evenness and environmental factors temperature 30-32 ° C, air humidity between 45-60%, and wind speed ranging from 1-3 m/s.

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