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Comparison of Insect Diversity in Long Bean (*Vigna sinensis* L.) and Corn (*Zea mays*) Plantations in Banjarsari Village, Serang City, Banten

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Abstract. This study aims to compare the diversity of insect species and their ecological roles in two types of crops, namely long beans (*Vigna sinensis* L.) and corn (*Zea mays*), cultivated in Banjarsari Village, Serang City, Banten. The study was conducted over two days in March 2025, utilizing observation and sampling methods with a single-sweep technique in both the morning and afternoon sessions. The results showed that the long bean plantation had higher insect diversity compared to the corn plantation. In total, 14 insect species were identified, belonging to 11 families and five orders, with ecological functions classified as herbivores, predators, and pollinators. The species *Valanga nigricornis* was the most dominant herbivore, especially on long bean plants. Meanwhile, species from the Formicidae and Libellulidae families acted as natural predators, and the species *Apis cerana* and *Ropalidia marginata* functioned as pollinators. Environmental factors, including vegetation type, soil moisture, and food availability, influenced the presence of various insect types. The results of this study underscore the significance of insect diversity as an indicator of agricultural ecosystem stability, as well as a crucial component in the management of sustainable agroecosystems.

Keywords: Corn; Diversity; Insect; Long bean

I. INTRODUCTION

Indonesia has a tropical climate, with warm temperatures and high humidity throughout the year. These conditions are very supportive of the growth of long bean (*Vigna sinensis* L.) and corn (*Zea mays*) plants, both of which play an important role in Indonesia due to their ability to adapt well in various regions with different altitudes, making them one of the foodstuffs that the Indonesian people widely consume. The combination of these two plants has the potential to support diversification efforts, thereby strengthening food security and enhancing the quality of community nutrition. (Mu'amalah *et al*.,2024).

According to data from the Central Agency for Agricultural Statistics from 2020 to 2022, the production and harvest area of corn in Indonesia fluctuated. In 2020, the harvested area was 3,075,715 hectares, and the harvest production was 20,158,040.66 tons. However, in 2021, the harvest area decreased to 2,977,314.4 ha, while harvest production increased to 20,499,835.43 tons. Then, in 2022, the harvest area increased to 3,325,042 ha, and harvest production was 24,022,415.27 tons. In contrast, long bean beans show different data. In 2020, the harvested area was 188,552.8 hectares, and the harvest production was 198,482.8 tons. Then, in 2021, there was a slight increase, with a harvest area of 193,063 ha and a harvest production of 222.14 tons. In 2022, there was a significant decrease, with a harvest area of 100,224.9 ha and harvest production of 122,343.11 tons.

This production growth is inextricably linked to ecological challenges, including insect activity that impacts agricultural yields. The balance of environmental factors strongly influences the diversity of insect species in an ecosystem. According to Odum (1996) and Suheriyanto (2008), an ecosystem with controlled and stable conditions will exhibit low insect diversity, whereas high insect diversity is an indicator that the ecosystem is in a balanced or stable state. Each region has a unique set of insects, influenced by different environmental factors.

Insect diversity also varies between regions, depending on environmental factors. According to Subekti (2012), these factors include natural selection, light intensity, vegetation type, rainfall, food availability, soil moisture, and the ability of insects to travel from one region to another. Generally, the environment plays a crucial role in determining insect diversity, as each type of insect has distinct environmental requirements. When viewed from the trophic level, insects can be classified into several groups, namely predators, herbivores, and pollinators (Borror, 1981). This study aims to compare the insect diversity in two plantations, namely long beans and corn, in Banjarsari Village, Serang City, Banten.

II. METHODS

The research was conducted over two days, on March 8-9, 2025, with four observation sessions (morning at 08:00 and evening at 16:00) in two plantation locations: long beans and corn in Banjarsari Village, Serang City, Banten. The tools used included insect nets to capture insects, soil testers to check soil conditions, killing bottles, triangular paper to store specimens, millimeter block paper to facilitate insect measurements, and materials such as chloroform and cotton for anesthetic purposes.

The insect sampling process was conducted using a single swing method around corn and long bean plants. Captured insects can be placed in a plastic bag (Kurnia et al., 2020). After capturing insect samples, the collection process is carried out by inserting the insects into a collection bottle or a ziploc plastic bag that already contains anesthetic material. Insect identification references are based on the last 10 years of journals and books. This research employs descriptive methods, analyzing data by calculating the diversity value using the Shannon-Wiener index.

The formula used to calculate the Shannon-Wiener index is below:

$$H` = - \Sigma Pi \ln Pi, \text{ where } Pi = ni/N$$

Description:
H’ = Shannon-Wiener Diversity Index; Pi = Relative abundance of each species; ni = Total individuals of species-i; N = Number of individuals of all species (Magurran, 2014).

Simpson's dominance index can be used to determine the species that dominate a community. The formula used to calculate the dominance index according to Simpson is below:

$$D=\Sigma(ni/\mathrm{N})^2$$

Description:
D = Simpson's dominance index ni = Total individuals of the i-th species; N = Total individuals; S = Number of Species (Krebs, 2009).

III. RESULTS AND DISCUSSION

A. Insect species and ecological roles

Based on research conducted in both long bean and corn plantations, 14 insect species were identified, comprising 11 families and five orders. The observation of the role of insects shows that herbivores are insects that visit both long bean and corn plantations, as shown in Table 1.

String bean plantations tend to attract more insects than corn plantations, including herbivores, predators, and pollinators. The most common herbivorous insect species was *Valanga nigricornis*, with a higher population in the long bean field, reaching 10 individuals, while only three individuals were found in the maize field. Herbivorous insects are considered harmful organisms because their feeding activity directly damages plant tissues, such as leaves, stems, or fruits. The impact of this attack is a decrease in both the quality and quantity of crop yields, resulting in economic losses for farmers (Sari *et al*., 2017).

In addition to plant-eating insects, the presence of predatory insects is also important in maintaining the balance of agricultural ecosystems. Among this group are members of the Hymenoptera order of the Formicidae family and the Odonata order of the Libellulidae family. Predatory insects act as population controllers of other insects by directly preying on their prey, sucking body fluids, or consuming all parts of their target's body. According to Melketa *et al. (2022),* this action not only sustains the life of the predator but also ensures the continuity of its reproduction, thereby supporting the stability of the agricultural ecosystem.

Pollinator groups were also found in both plantations, with the Hymenoptera order being the most dominant. Common species included *Apis cerana* and *Ropalidia marginata*. Pollinators play an important role in the pollination process of various crops, including food crops. Their presence significantly contributes to the sustainability of ecosystems and the world's food supply, with a contribution to global production reaching approximately 35% (Batubara, 2022). Research by Rahmani *et al*. (2020) identified three main species involved in pollinating long bean plants: Xylocopa sp., *Tetragonula laeviceps*, and *Lampides boeticus*. All three actively collect nectar and pollen, thus directly supporting plant productivity through an effective pollination process.

Meanwhile, the dynamics of insect populations on maize plants varied depending on the growth phase. In the vegetative phase, three dominant species were found, namely *Lagria* sp. (33.34%), *Micraspis discolor* (16.67%), and *Menochilus sexmaculatus* (11.12%). In the generative phase, the dominance shifted to *Micraspis discolor* (25%), *Oxyopes* sp. (16.67%), and *Micraspis lineata* (12.5%). These insect species primarily serve as natural biological control agents, helping to suppress pest populations and thereby increasing the sustainability of corn crop production (Ervianna, 2019).

TABLE 1. INSECT SPECIES IN LONG BEAN AND CORN PLANTATIONS

No	Order	Family	Species	Number of insects		Role
				Long bean	Corn	
1	Ortophtera	Pyrgomorphidae	*Atractomorpha crenulata*	2	2	Herbivor
		Acrididae	*Valanga nigricornis*	10	3	Herbivor
2	Hymenoptera	Apidea	*Xylocopa latipes*	4	0	Herbivor
			Apis cerena	3	0	Polinator
		Formicidae	*Oeocophylla smaragdina*	2	0	Predator
			Lasius niger	1	3	Predator
		Vespidae	*Ropalidia marginata*	1	0	Polinator
		Alydidae	*Leptocorisa acuta*	1	2	Herbivor
3	Coleoptera	Scarabaeidae	*Protaetia fusca*	1	2	Herbivor
4	Lepidoptera	Hesperiidae	*Pelopidas mathias*	3	1	Herbivor
		Pieridae	*Appias linbythea*	2	0	Herbivor
		Nymphalidae	*Melanitis leda*	2	0	Herbivor
5	Odonata	Libellulidae	*Pantala flavescens*	1	0	Predator
			Orthetrum sabina	2	1	Predator

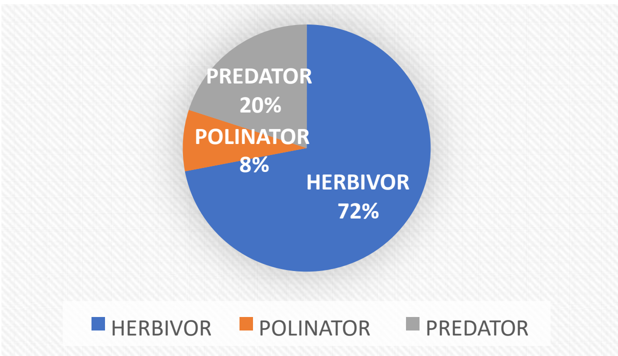

Figure 1. Competition and the role of insect species in two plantations

Ortophtera

The identification of insects in the order Orthoptera in long bean and corn plantations in Banjarsari Village, Serang City, Banten, revealed the presence of two species from two different families: the Pyrgomorphidae family and the Acrididae family. For the Pyrgomorphidae family, there is one species, namely *Atractomorpha crenulata,* which can be seen in Figure 1 (A). The Acrididae family has one species, namely the *Valanga nigricornis* species, as shown in Figure 1 (B).

Atractomorpha crenulata, or the green grasshopper shown in Figure 1 (A), has the characteristics of a cone-shaped caput measuring 9 mm, antennae measuring 6 mm, and its body is light green. Yuliyati *et al.* (2024) revealed that the Pyrgomorphidae family exhibits characteristics such as a cone-shaped head, short antennae, and a pronotum that does not extend backward to cover the abdomen. In addition, there are fastigial grooves and capsule-like ectophallus structures in the phallic complex. This insect typically inhabits tropical and subtropical regions. The mouthparts chew and bite, so the leaves are generally eaten at the edge of the leaf. Green locusts have two kinds of locomotor organs, namely wings and legs, and a body diameter of up to 50 mm (Hidayah *et al*., 2024).

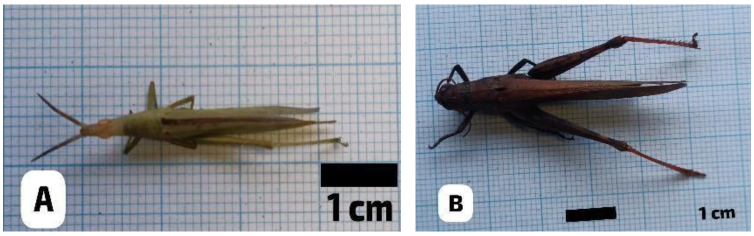

Figure 2. Insect species of the order Ortophtera, (A) *Atractomorpha crenulate and* (B) *Valanga nigricornis*

Figure 2 (B) shows Valanga Nigricornis, or wood locust, has a green-brown body; there are spots on the hind thigh area, a pair of antennae measuring 4 mm, and yellow and red calf bones. Meanwhile, according to Yuliyati et al (2024), the Acrididae family is characterized by short antennae, a pronotum that does not extend backwards, tarsi with three segments, enlarged hind leg femurs, and a short ovipositor. The body size of females in this family is larger than that of males. Most species are gray or brown, although some have brightly colored hind wings.

Hymenoptera

Based on the identification of insects of the order Hymenoptera in long bean and corn plantations in Banjarsari Village, Serang City, Banten, six species from four different families were identified: Apidae, Formicidae, Vespidae, and Alydidae. For the Apidae family, there are two species: Xylocopa latipes and Apis cerena, as shown in Figure 3. The Formicidae family has two species, namely *Oecophylla smaragdina* and *Lasius niger* species; the Vespidae family has one species, namely Ropalidia marginata species; the Alydidae family has one species, namely *Leptocorisa oratorius* species.

Figure 3 (A) shows that the wood bees (*Xylocopa latipes*) are large and hairy bees with wing sizes that vary according to their habitat. Bees inhabiting higher altitudes tend to have larger wings, which is believed to be an adaptation for increased flight speed in these environments. Wood bees have a larger hind leg size in primary forests than in other habitats (Windarsih & Manap, 2021). According to Nur'aini and Hari Purwanto (2021), *Apis cerena* bees have a dark black body with the characteristics of the head having a black clipeus and black antennae consisting of scapel and pedicel, the thorax is black with yellow-brown fur, the hind legs are black with brown fur, while the hind tibia has dense hair (plumose), Tegula is solid black, This can be seen in Figure 3 (B).

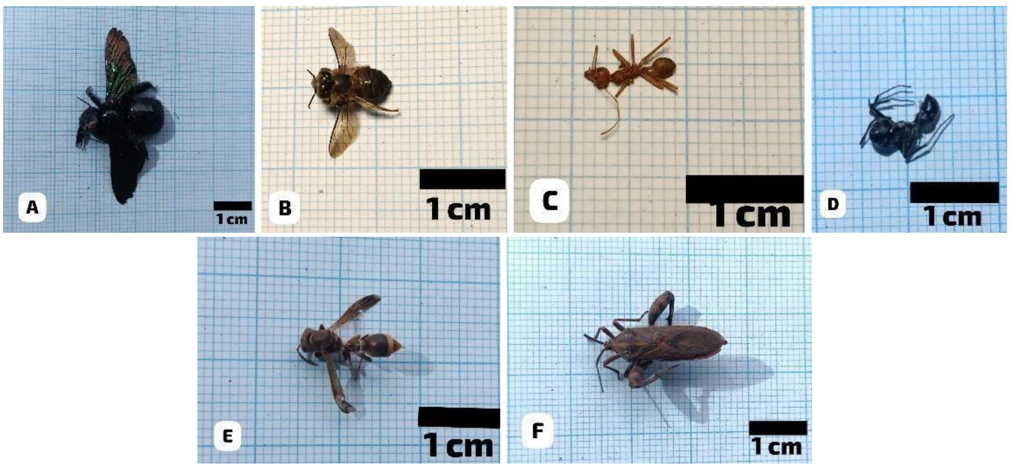

Figure 3. Insect species of the order Hymenoptera: (A) *Xylocopa latipes,* (B) *Apis cerena,* (C) *Oecophylla smaragdina,* (D) *Lasius niger,* (E) *Ropalidia marginata,* (F) *Leptocorisa acuta.*

Figure 3 (C) is Oecophylla smaragdina. According to Offenberg & Wiwatwitaya, as explained in Anggraini et al. (2023), *Oecophylla smaragdina* has a pink body color, a round head (caput) with a slightly tapered front, and a segmented abdomen. In addition, the antennae are segmented, long, and slender. Octamil *et al* (2021) state that *Lasius niger* has a black body with an oval-shaped head and oval eyes on the side. The base of the abdomen is visibly narrowed, while the second abdominal segment is connected to a stalk that forms a narrow waist between the metasoma. *Lasius niger* is often found in trees or shady places near food sources. An image of Lasius niger is shown in Figure 3(D).

Figure 3 (E) shows an image of Ropalidia marginata. According to Saputri *et al. (2024), Ropalidia marginata* has a brown, yellow, and black body. This insect has six leg segments, two antennae on its head, and a pair of thin, black, and yellowish-brown wings. According to Sari *et al* (2021), in the imago phase, *Leptocorisa acuta* has a body size of 1.7-1.8 cm and a width of 0.2-0.3 mm. The antennae are 1.4 cm long with four segments that have a white base. The stylet measures 0.4-0.5 cm. The abdomen is white with brown edges, consisting of 6 segments. On the 2nd, 3rd, and 4th segments, there are brown spots. The body is green-brown, and the wings are fully developed. An image of the insect is shown in Figure 3 (F).

Coleoptera

Based on the identification of insects of the order Coleoptera in long bean and corn plantations in Banjarsari Village, Serang City, Banten, the presence of 1 species from 1 family was observed, namely the Family Scarabaeidae. According to Nasution *et al.* (2024), the mango flower beetle, or Protaetia fusca, has a sparse, mottled body pattern with a surface between blunt punctures. This beetle is a plant pest (herbivore) because it can damage flowering plants. Adult beetles eat plant pollen in cemented sap and ripe fruit. An example of the insect can be seen in Figure 4 (A).

Figure 4. Insect species of the order Coleoptera, (A) Protaetia fusca.

Lepidoptera

The results of identifying insects of the order Lepidoptera in long bean and corn plantations in Banjarsari Village, Serang City, Banten, showed the presence of three species from three families: Hesperiidae, Pieridae, and Nymphalidae.

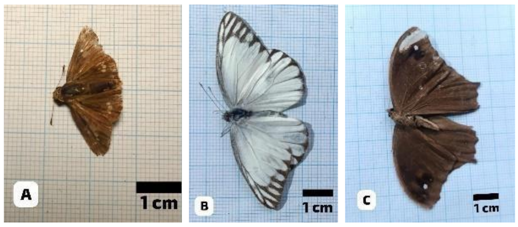

Figure 5. Insect species of the order Lepidoptera, (A) *Pelopidas mathias,* (B) *Appias linbythea,* (C) *Melanitis leda*

Figure 5 (A) is an image of Pelopidas mathias, which, according to Lubis et al. (2022), revealed that Pelopidas mathias has a bilateral body consisting of three main parts: the head (caput), thorax, and abdomen. This butterfly has large and prominent compound eyes and is equipped with a pair of antennae. The basic body color is dark brown-black, with brown wings that have a span of about 2.2 centimeters.

Figure 5 (B) is Appias libythea. According to Chahyadi *et al.* (2019)*,* Appias libythea has a black and white body color. The head is black, measuring 1.7 mm in length, and is equipped with round-tipped black antennae and a black proboscis. The labial pulp is white. The upper thorax is black, while the lower thorax and limbs are white. The wings are predominantly white, with tapered upper wing tips and smooth lower wing edges. On the abdomen, black dominates the upper part, while the lower part is white. Research by Chahyadi et al (2019) revealed that *Melanitis leda* has a dominant brown color on almost its entire body, starting from the head, antennae, mouth, chest, abdomen, and legs, which are brown, except for the labial palpi (sensor organs near the mouth), which are white. The wings are brown with pointed upper wing tips, while the lower wings have a slight protrusion like a small tail. An image of the insect is shown in Figure 5(C).

Odonata

According to Rizal and Mochamad (2015), *Pantala flavescens* is a species of Anisopthera characterized by a large body, with an abdominal length of 29-35 cm. The body is predominantly yellow, with whitish patterns throughout, and features black legs and black patterns on the tail segments. Another characteristic is that the hind wings are notched at the base, and the front wings are wider. Atourrohman *et al* (2020) revealed that *Orthetrum sabina* has a dark green thorax with black stripes on the sides and black legs. The abdomen is slender with a black and white pattern, where the first three segments are the same color as the thorax. The embella (anal appendix) is white, while the wings are transparent with a brown pteristigma at each end. The phenula on these wings is colorless.

The diversity and abundance of insect populations were more prominent in the long bean field compared to the maize field, as shown in the comparison graph (Table 1). The insect community in the bean field shows a more varied species distribution and a higher number of individuals. In contrast, in maize fields, both the number of species and total population tended to be lower. Among all the species observed, Valanga nigricornis (family Acrididae) was the most abundant species. In contrast, *Ropalidia marginata* (family Vespidae) and *Pantala flavescens* (family Libellulidae) were only found with one individual each in the bean field. They were not identified at all in the maize field. Examples of insects are shown in Figure 6.

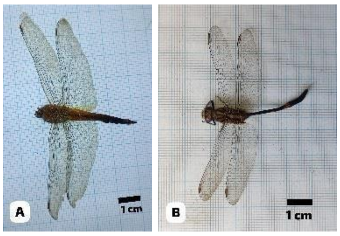

Figure 6**.** Insect species of the order Odonata (A) *Pantala flavescens* (B) *Orthetrum sabina*

B. The Diversity Index

The results showed that the Shannon-Wiener diversity index (H') of the insect community in the bean field reached a value of about 2.41, while in the maize field it was recorded at 1.74. Based on the diversity classification criteria, the H' value in the bean field was in the “high” category, while in the maize field it was in the “medium” range. In general, H' values between 1 and 3 indicate a moderate level of diversity, while values above 3 reflect highly complex ecosystem conditions. Therefore, these results indicate that the farmlands studied are still able to support a variety of insect species, although they do not yet show very high diversity.

Among the 14 insect species identified, *Valanga nigricornis* was the species with the highest dominance, with 10 individuals found in the bean field and three individuals in the maize field. This abundance suggests that the environmental conditions in the bean field are highly favorable for the locust's life and reproductive activities, in terms of food availability, vegetation structure, and microhabitat conditions. In contrast, the low abundance of Ropalidia marginata and Pantala flavescens indicates that these species may have more specific habitat preferences or are less suitable for homogeneous agricultural ecosystem conditions.

Overall, the observed variation in diversity is not only determined by the number of species (richness), but also by the uniformity of the distribution of individuals among these species (evenness). This evenness is reflected by the dominance of one or a few species, while other species have very few representative individuals. This may be related to uniformity in cultivation practices, monotonous vegetation structure, and lack of diversification of resources and habitats.

Overall, these differences in diversity index values illustrate the uneven distribution of individuals among species. Although the number of species is quite diverse, some of them significantly dominate the population, while others are present in minimal numbers. This imbalance suggests that the structure of the insect community is uneven, which could be influenced by the relatively uniform conditions of the agroecosystem. Monoculture cultivation, lack of diverse vegetation structure, and homogeneous agricultural applications can limit the formation of microhabitats that support a variety of insect species. The lack of variation in resources and shelter may prevent species with specialized ecological needs from thriving.

This finding is in line with the Shannon-Wiener diversity theory proposed by Magurran (2014), which states that species diversity is not only determined by the number of species (richness), but also by how evenly distributed individuals are among species (evenness). An imbalance in the distribution of individuals prevents the diversity value from reaching the highest category, despite the large number of recorded species. Therefore, to increase insect biodiversity, a more ecologically and sustainably managed land management strategy is needed. The implementation of environmentally friendly agricultural practices and increased vegetation heterogeneity could be key to creating agroecosystems that are more inclusive of a wide range of insect species and support long-term ecological balance.

CONCLUSION

Based on the results of this study, it can be concluded that long bean (Vigna sinensis L.) and corn (Zea mays) plantations in Banjarsari Village, Serang City, Banten, have moderate insect diversity. Insects identified in both plantations belong to 14 species, five orders, and 11 families. The Shannon-Wiener diversity index value was approximately H' ± 2.41 for long bean plantations and H' ± 1.74 for corn plantations. Insects in these plantations play diverse ecological roles, including serving as herbivores, predators, and pollinators. Herbivorous insects, such as Valanga nigricornis, were dominant in both plantations. The dominant pollinator insect was *Apis* *cerena*, and the dominant predator insect was Oecophylla smaragdina. The percentage of insects consisted of 72% herbivorous insects, 20% predatory insects, and 8% pollinator insects, comprising 35 herbivorous insects, 10 predatory insects, and four pollinator insects.

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