DIVERSITAS HAYATI
Volume 3, Number 1, Juni 2025
Pages: 1-5

ISSN: 3025 - 2237

Diversity of Aerial Insects and their Status in Nagara Sweet Potato (*Ipomea batatas* L.) Crops in Lebak Swamp

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Manuscript received: 16 May 2025. Revision accepted: 26 June 2025.

Abstract. South Kalimantan possesses the potential for extensive wetland swamps that have not been fully utilized optimally for agricultural purposes. One particular commodity that demonstrates adaptability to the unique characteristics of the swamp environment is the Nagara sweet potato (*Ipomoea batatas* L.). The Nagara sweet potato plantation ecosystem is also a habitat for various types of aerial insects that play an important role in ecosystem balance, both as pests, natural enemies, and bioindicators. The objective of this study is to ascertain the diversity and status of aerial insects in Nagara sweet potato plantations on Lebak swamp land. The research was conducted from May to July of 2024 in Daha Selatan District, Hulu Sungai Selatan Regency. The research method employed was a descriptive exploratory approach, leveraging a purposive sampling technique. The collection of samples was executed through the utilization of sweep nets and yellow traps, followed by identification utilizing an insect determination key book. The results of the study indicated the presence of 12 species of aerial insects, classified into six orders and nine families, with specific details regarding their status. This included two pest species, six natural enemy species, and four bioindicator species. The Shannon diversity index (H') of 0.99 is low, the evenness index (E) of 0.895 is high, the species richness index (R) of 5.176 is high, and the dominance index (D) of 0.099 is low. The high presence of natural enemies suggests that the Nagara sweet potato plantation ecosystem is relatively stable and possesses the capacity for natural pest control. This finding can serve as a foundation for the development of a sustainable agricultural system on Lebak swamp.

Key words: Insects, Lebak Swamp, and Nagara Sweet Potato.

INTRODUCTION

Lebak swamp is an area that experiences seasonal inundation, which often results in its being regarded as less conducive to conventional agricultural practices. However, in contrast to this common perception, there are crops that have been observed to thrive in this region, including sweet potato (*Ipomea batatas* L.). Sweet potato (*Ipomoea batatas* L.) is a crop that can be cultivated in the Lebak swamp area [1].

Sweet potato (*Ipomoea batatas* L.) is a food crop that is simple to cultivate and does not require specific seasonal conditions for growth. It can be cultivated and developed throughout Indonesia. According to Sarwono's (2005) [2] research, Indonesia holds a prominent position in global sweet potato production, ranking fourth worldwide after China, Uganda, and Nigeria. Sweet potatoes can be harvested at intervals of up to four months, with the potential to yield more than 30 tons per hectare, contingent on the method of processing or cultivation, the characteristics of the soil, and the type of seeds employed. This phenomenon is evident in various regions across Indonesia, although the national average sweet potato productivity remains at 12 tons per hectare.

Sweet potato serves as a habitat for a variety of insects. The diversity of insects inhabiting sweet potato plants mirrors the intricate dynamics of agricultural ecosystems. The insects found on sweet potatoes can act as pests, but many are also an integral part of the ecosystem. These insects help in the process of pollination, decomposition of organic matter, and as part of the food chain. Among the animal groups classified within the phylum Arthropods, as well as all other animal groups, insects are the most prevalent. The structural characteristics of insects, including wings, antennae, and body shape, exhibit significant diversity. As stated in Kedawung (2013) [3], insects facilitate a variety of functions for plants and other animals, including humans.

The class Insecta comprises organisms that are ubiquitous, with a vast geographical distribution and a high population density. According to the work of Pracaya (2003) [4], insects comprise approximately 75% of all animal species, making them the largest group of animals. The Indonesian archipelago boasts a rich biodiversity, with its insect fauna comprising an impressive 250,000 species, accounting for approximately 15% of the total main biota species within the country [5]. This observation underscores the pivotal role of insects within ecological systems, particularly in swamp ecosystems. Furthermore, there are insects that possess wings, which are typically utilized for flight. These insects are designated as "aerial insects" [6]. Rizali (2002) [7] posited that the stability of agricultural ecosystems can be gauged by the abundance of insect diversity in agricultural locations. The relationship between the diversity of insects at the air-plant interface and the stability of the ecosystem is evident through the determination of community structures and the properties of ecosystem components, as well as the interactions between these components.

Sweet potato plants (*Ipomoea batata* L.) generally exhibit robust growth in the absence of insect control measures, underscoring the intricate dynamics of the ecosystem that fosters their natural equilibrium. It is hypothesized that the unique ecological conditions in the Lebak swamplands create a favorable environment for sweet potato growth while maintaining insect populations at levels that are both beneficial and detrimental. To date, no research has examined insect diversity in sweet potato crops in this region. Therefore, the present study is of considerable importance in determining the types of insects that are potentially beneficial or harmful in the sweet potato farming ecosystem in Lebak Swamp Land.

The objectives of this study are to determine the diversity of aerial insects on nagara sweet potato (*Ipomea batatas* L.) plants in Lebak swamp land and to assess the status of aerial insects on nagara sweet potato (*Ipomea batatas* L.) plants in the Lebak swamp land.

MATERIALS AND METHODS

The materials used included alcohol, sample bottles, observation sheets, stationery, label paper, insect nets, yellow traps, meters, cameras, and microscopes.

This research was conducted using exploratory methods, namely observation and direct sampling from the observation location. The sampling technique employed in this study was purposive sampling. The following criteria were employed: the presence of insects observed from the air in Nagara sweet potato plantations in Lebak swamp land.

The research stages are as follows: observation, insect sampling, and identification.

Observations

Observations were made to ascertain the condition of the research location, thereby providing a foundation for determining sampling points.

Sampling

The sampling method employed involved the utilization of insect nets and yellow traps, which were subjected to the following stages:

1. The insect net traps (sweep net) are deployed in a methodical manner, with each trap being swung ten times at eight distinct locations on the Nagara Yam plot. The captured insects are then meticulously collected, separated, and placed into a sample bottle for subsequent identification.
2. The yellow traps were positioned in a diagonal configuration, with a total of eight traps arranged in the central area of the plot. The deployment of these traps occurred between 10:00 am and 2:00 pm. The insects that were captured were meticulously collected and separated. Subsequently, they were placed into a sample bottle for identification purposes.

Identification

The identification of the specimen was conducted in accordance with the protocols outlined in the Borror et al. (1996) [8] identification book and the insect determination key book.

Data analysis

The analysis of insect diversity was conducted through the calculation of several indices: the Diversity Index, the Evenness Index, the Species Richness Index, and the Species Dominance Index.

Diversity Index (H')

$$H' = -\sum \frac{ni}{N} \times In \frac{ni}{N}$$

where:
H' : Shannon Diversity Index (a measure of diversity)
ni : Number of individuals of the i-th species
N : Total number of individuals (sum of all *ni*)
With criteria:
$H' < 1$: Low diversity
H' *1–3* : Medium diversity
$H' > 3$: High diversity

Evenness Index (E)

$$E = \frac{H'}{In\ S}$$

where:
E : Evenness index
H' : Diversity index
S : Total species

Species Richness Index (R)

$$R = \frac{S-1}{In\ N}$$

where:
R : Species richness index
S : Total number of species
N : Number of all species

Species Dominance Index (D)

$$D = \sum_{i=1}^{S} \left(\frac{ni}{N}\right)^2$$

where:
D : Dominance index
ni : Individual index of each species
N : Number of individuals of all species
With criteria:
$C < 0.4$: Low dominance index
$0.4 < C < 0.6$: Medium dominance index
$C > 0.6$: High diversity

RESULTS AND DISCUSSION

A total of 12 species of insects were identified in the field, categorized into six orders, nine families, and 12 species. These findings are outlined in Table 1.

Table 1. Types of aerial insects found in Nagara sweet potato plantations

Ordo	Family	Species	Status	Population
Diptera	Scenopinidae	*Scenopinus fenestralis*	Natural Enemies	2
Coleoptera	Coccinellidae	*Cynegetis Impunctata*	Bio-Indicators	1
Coleoptera	Coccinellidae	*Coccinella transversalis*	Natural Enemy	3
Coleoptera	Coccinellidae	*Verania discolor*	Natural Enemy	2
Hymenoptera	Sphecidae	*Sceliphron Madraspatanum*	Natural Enemy	5
Hymenoptera	Sphecidae	*Ammophila sabulosa*	Natural Enemy	1
Hymenoptera	Torymidae	*Torymus cecidomyae*	Bio-Indicator	2
Hemiptera	Reduviidae	*Pnirontis modesta*	Natural Enemies	1
Hemiptera	Pentatomidae	*Zicrona caerulea*	Pests	1
Orthoptera	Gryllidae	*Euscyrtus concinnus*	Bio-Indicators	1
Orthoptera	Acrididae	*Valanga nigricornis*	Pests	1
Odonata	Libellulidae	*Orthetrum sabina*	Bio-Indicators	1
Total				21

As illustrated in Table 1, a total of six orders, nine families, and 12 species of aerial insects were identified on the nagara yam (*Ipomea batatas* L.) plants in the lebak swamp land. The most prevalent insect was the wasp (*Sceliphron madraspatanum*), suggesting the preeminence of this species. The high number of wasps is likely influenced by the availability of suitable prey, such as spiders, which inhabit the lebak swamp habitat [9]. Favorable environmental conditions, including humidity, temperature, and plant structure, also contribute to increased wasp activity. According to Effendy et al. (2014) [9], the topography of shallow lebak land, characterized by the accumulation of silt from nearby rivers, fosters the creation of fertile soil, thereby providing an optimal environment for the proliferation of wasp nests. Furthermore, wasps (Hymenoptera) function as natural predators, thereby contributing to the maintenance of ecosystem balance.

Conversely, the presence of other insect species was documented, albeit in low numbers. The factors that may have contributed to their limited abundance include habitat limitations, interspecies competition, or the constraints imposed by the duration of the sampling period. This biodiversity is indicative of the intricate ecological interactions present within nagara sweet potato crops and can serve as a metric for evaluating pest management strategies and assessing the health of the agroecosystem.

A further element exerting an influence on the diversity of insects is rainfall. In September, Daha Selatan region documented 63 millimeters of precipitation over a period of five days. This is classified as low to moderate rainfall. These conditions resulted in a relatively ideal environment for the proliferation of aerial insect species in Nagara sweet potato plantations, as evidenced by the presence of 12 distinct insect species, including natural enemies, pests, and bioindicators.

Natural enemies such as *Scenopinus fenestralis* and *Verania discolor* exhibited high levels of activity, while pests such as *Zicrona caerulea* began to appear, although they did not dominate. Furthermore, the presence of multiple bioindicator species suggests that the ecosystem remains stable. This finding aligns with Wardani's (2017) [10] assertion that substantial precipitation can lead to increased insect mortality, while low to moderate rainfall fosters optimal conditions for insect population growth. This assertion is further substantiated by the findings of Sofyan et al. (2019) [11], which indicate a robust correlation between rainfall, minimum humidity, and the number of rainy days with insect population dynamics. Consequently, the prevailing weather conditions in September in Daha Selatan fostered the proliferation of diverse insect species within the nagara yam agricultural ecosystem, including those that function as natural enemies, pests, and bioindicators.

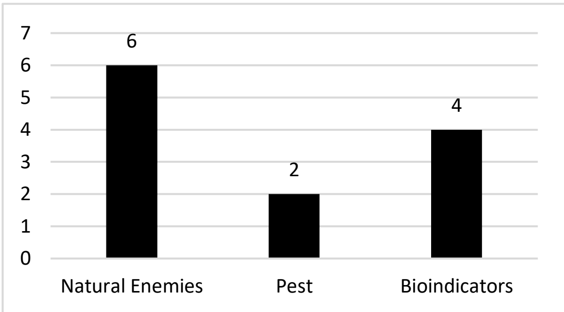

Figure 1. The distribution status of aerial insects in Nagara sweet potato plantations is based on the number of species.

As shown in Figure 2, which presents a graphical representation of the distribution of insect status in Nagara sweet potato plantations, the natural enemy insect group exhibits the greatest prevalence, with a population of up to 6 individuals. This is followed by bio-indicators, which include 4 species, and finally insect pests, which account for 2 species. The high number of natural enemies suggests that the ecosystem balance in the nagara yam field is relatively well maintained and that natural pest control is a viable option. This finding aligns with the observations of Arifin et al. (1997) [12], who asserted that natural enemies encompass a wider spectrum than pests, comprising 29 distinct types of natural enemies, 16 types of pests, and 11 non-status species within a 1-hectare rice field unit. It is imperative to acknowledge the pivotal function of parasitoids and predators as natural enemies in the ecological management of pest populations.

Preliminary observations indicate the presence of two species of insects classified as pests: *Zicrona caerulea* and *Valanga nigricornis*. In the order Isoptera, the suborder Blattodea, and the family Cimicidae, there are species of *Scenopinus fenestralis*, *Coccinella transversalis*, *Verania discolor*, *Sceliphron madraspatanus*, *Ammophila sabulosa,* and *Pnirontis modesta* that have been classified as "insects with natural enemy status." A number of species of insects have been identified as bio-indicators, including those of the genera *Cynegetis impunctata*, *Torymus cecidomyae, Euscyrtus concinnus*, and *Orthetrum sabina*. These species are found in the order Odonata.

The proportion of aerial insect status in Nagara sweet potato plantations has been shown to be indicative of the presence of a greater number of enemies. This, in turn, has been found to be associated with ecosystem stability, whereby the pest population is controlled by natural enemies. This finding is corroborated by diversity analysis data, as illustrated in Table 2.

Table 2. The diversity index, evenness index, species richness index, and dominance index of aerial insects in a Nagara sweet potato plantation.

	Diversity Index (H')	Evenness Index (E)	Species Richness Index (R)	Species Dominance Index (D)
Values	2,536	0,895	5,176	0,099

According to the findings presented in Table 2, the diversity index value (H') of aerial insects in the nagara yam plantation is 2.536, which is classified as high. The elevated value of this index suggests that the insect community in the area possesses a relatively diverse and balanced species composition. This finding aligns with the assertion put forth by Mulyasana (2008) [13], which posits that the value of the species diversity index is contingent on two primary factors: species richness, defined as the total abundance of species, and species evenness, conceptualized as the distribution of species within a given community. Peet (1974) [14] also posited that the H' index is a combination of species richness (number of species) and evenness or equitability. Consequently, the elevated value of H' in Nagara sweet potato plantations signifies the presence of a diverse array of insects, with a balanced distribution of their population sizes across different types.

The evenness index (E) of aerial insects in Nagara yam plants attained a value of 0.895. According to Odum (1993) [15], as the E value decreases, the distribution of species becomes more limited, while an increase in the E value indicates a more even distribution of species. E values between 0 and 0.4 indicate low evenness, between 0.4 and 0.6 are moderate, and between 0.6 and 1.0 are high. Consequently, the value of 0.895 signifies that the evenness of aerial insect species in the nagara yam field is classified as high. This indicates that the population sizes of each species within the community are relatively balanced, with no significant dominance by a single species.

The calculated species richness index is 5.176, suggesting a high species richness. According to Normasari (2012) [16], this value is likely influenced by various environmental factors, including food availability and habitat conditions. Haneda et al. (2013) [17] also posited that season, as well as temperature and humidity, affect insect activity and development. As posited by Alfai et al. (2022) [18], biotic interactions—that is, interactions among organisms—such as competition and the presence of natural enemies, have been demonstrated to exert a significant impact on the survival and number of insect species in a community.

The dominance index (D) of aerial insects in Nagara sweet potato plantations is 0.099, according to Putriyani et al. (2024) [19] The dominance index of insects can be calculated using Simpson's Dominance Index. The objective of the dominance value is to ascertain the predominant insect species within the designated study area. As Vincentus (2020) [20] elucidated, the dominance index is a metric employed to assess the predominance of an insect group over other groups. It has been demonstrated that as the dominance index value (C) increases, the degree of dominance exhibited by certain species also increases. The value documented in Table 2 is 0.099, indicating that the level of dominance in the Nagara sweet potato plantation is low. Riyanto (2016) [21] posits that in the event of a low dominance index, no single species exerts significant dominance over the community. The relationship between the dominance index value and the diversity index is inverse.

CONCLUSION

The diversity of aerial insects in cassava plantations on lowland swampy land was found to be 2,536, which is classified as high. The evenness index, which ranges from 0 to 1, with 1 representing perfect evenness, was determined to be 0.895, thus indicating high evenness. The species richness index is 5.176, which is classified as high. The dominance index, which ranges from 0.000 to 1.000, is 0.099, thus falling into the low category. The classification of the aerial insects found in cassava plantations is as follows: pests (2 species), natural enemies (6 species), and bio-indicators (4 species).

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