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(RESEARCH ARTICLE)

COMMUNITY STRUCTURE AND POPULATION FLUCTUATIONS OF PHYTOPHAGOUS INSECTS IN ORGANIC AND CONVENTIONAL RICE AGROECOSYSTEMS IN TEGAL SARI VILLAGE, EAST OGAN KOMERING ULU REGENCY, SOUTH SUMATRA, INDONESIA

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ABSTRACT

Differences in rice cultivation practices may influence the abundance, diversity, and community structure of phytophagous insects. This study aimed to compare the abundance, diversity, and population dynamics of phytophagous insects in organic and conventional rice agroecosystems. Sampling was conducted using the diagonal sampling method, with five sampling plots established in each rice field. Each plot consisted of 20 rice clumps as observation units. Insects were collected through direct field observations and using yellow sticky traps, light traps, and sweep nets at seven-day intervals throughout one growing season. The results showed that a total of 5,225 phytophagous insects, representing 10 species, were recorded across both cultivation systems. Total insect abundance was higher in the organic field (2,758 individuals) than in the conventional field (2,467 individuals), with *Nephotettix virescens* being the most abundant species in both systems. Differences in community structure were also reflected in the ecological indices. The organic agroecosystem exhibited higher Shannon diversity (1.67) and Pielou evenness (0.73) indices than the conventional agroecosystem (1.60 and 0.69, respectively). In contrast, the Margalef species richness index was slightly higher in the conventional field (1.15) than in the organic field (1.14). Peak insect abundance occurred in the seventh week in the organic field (375 individuals) and in the eighth week in the conventional field (323 individuals). Spearman's rank correlation analysis indicated that positive interspecific associations predominated in both agroecosystems. Although both cultivation systems had the same species richness, they differed in the abundance and community structure of phytophagous insects.

Keywords: Insect diversity; Phytophagous insects; Organic rice; Conventional rice.

1 INTRODUCTION

Rice (*Oryza sativa* L.) is one of the world's most important food crops, as rice serves as a primary source of dietary energy for more than half of the global population, particularly in Asia (1). This strategic role makes rice production essential for meeting food demand and maintaining a stable rice supply across countries, including Indonesia. Rice is a staple food for most of the Indonesian population; therefore, sustaining rice production is a national priority for ensuring food availability and strengthening food security (2). In this context, organic agriculture has gained increasing attention as an alternative to conventional farming systems that rely heavily on synthetic fertilizers and pesticides. The need to sustain rice production has prompted greater attention to cultivation practices that focus not only on crop yields but also on environmental sustainability. This has encouraged the development of organic agriculture as an alternative that reduces dependence on synthetic inputs and emphasizes ecological processes in agroecosystem management (3). In rice cultivation, the transition to organic farming involves changes in management practices, including the use of organic inputs and the adoption of pest management approaches that place greater emphasis on ecological processes (4). In Indonesia, the development of organic rice production and consumption has also become part of broader efforts to promote more sustainable food systems (5). However, changes in cultivation practices involve more than simply replacing agricultural inputs; they may also affect habitat conditions and interactions among organisms within rice fields. Therefore, comparing organic and conventional rice agroecosystems is important for understanding how differences in crop management practices are associated with the occurrence and diversity of phytophagous insects.

Insect pests are among the biotic factors that can reduce rice productivity by damaging plant tissues and disrupting yield formation. Globally, yield losses in rice caused by pests and diseases are estimated to reach 30% of potential production (6). One of the major rice pests is the brown planthopper (*Nilaparvata lugens*), which can cause yield losses of 20–80%, depending on infestation severity and varietal resistance (7). These challenges underscore the importance of effective pest management that is also consistent with the principles of sustainable agriculture to maintain national rice production. In addition, Statistics Indonesia reported that national rice production declined from 54.75 million metric tons of milled dry grain (MDG) in 2022 to 53.98 million metric tons in 2023, accompanied by a decrease in harvested area from 10.45 million to 10.21 million hectares (8). Although this decline cannot be directly attributed to pest infestation, it further highlights the importance of managing crop pests and diseases to support the sustainability of rice production. In this context, differences in management practices between organic and conventional rice agroecosystems may influence the community structure of phytophagous insects, particularly through pesticide use and changes in interactions between pests and natural enemies. Arthropod species richness in organic rice fields was reported to be 40% higher than in conventional fields, with a greater increase among pest groups (75%) than among natural enemies (35%) (9). In contrast, no significant differences in insect species richness, abundance, or community composition were observed between the two cultivation systems (10).

Crop management practices are among the key factors shaping insect community structure in rice agroecosystems. The indiscriminate use of synthetic pesticides can disrupt natural enemy populations and trigger pest resurgence by weakening natural biological control and increasing pest reproduction (11). In contrast, organic farming systems may support arthropod diversity by limiting the use of synthetic chemicals, although responses among pest and natural enemy groups may vary depending on agroecosystem conditions (9). Recent studies have also shown that insect communities may respond differently to changes in cultivation systems, highlighting the need for field-based observations to identify patterns in species composition and community structure within each agroecosystem (12). Against this background, this study aimed to characterize the diversity and community structure of phytophagous insects in organic and conventional rice agroecosystems. The findings are expected to provide empirical information on species composition and diversity patterns of phytophagous insects in the two cultivation systems and to serve as a basis for developing sustainable rice agroecosystem management practices.

2 MATERIALS AND METHODS

2.1 Study Site and Characteristics of the Rice Agroecosystems

The study was conducted from December 2024 to March 2025 in Tegal Sari Village, East Ogan Komering Ulu Regency, South Sumatra, Indonesia. The study sites consisted of two rice fields managed under organic and conventional farming systems, each covering an area of 5,000 m^2 (0.5 ha). Both fields were planted with the Pandan Wangi Sintanur rice variety using the *jajar legowo* planting system. The cultivation practices differed in terms of fertilizer types, soil amendments, and pest and weed management methods (Table 1).

Table 1: Characteristics of organic and conventional rice farming systems

Management components	Organic system	Conventional system
Field area	5,000 m^2	5,000 m^2
Farmer age	46 years	48 years
Educational level	Senior high school	Senior high school
Planting system	Jajar legowo	Jajar legowo
Rice variety	Santanur	Santanur
Fertilizer inputs	Liquid organic fertilizer (goat urine, rice-washing water, molasses, and golden apple snail)	NPK fertilizer and urea
Soil amendments	Rice husk charcoal, animal manure, rice husks, coffee husks, and sugarcane bagasse	-
Pest management	Mechanical control and botanical pesticides derived from Andrographis paniculata, Aegle marmelos, and Tinospora crispa	Synthetic insecticides containing chlorantraniliprole, lufenuron, and fipronil
Weed management	Field sanitation	Herbicides containing paraquat dichloride, metsulfuron-methyl, florpyrauxifen, and cyhalofop-butyl

2.2 Sampling Methods and Insect Collection

Sampling was conducted using the diagonal sampling method, with five observation plots established diagonally across each study field. Each plot consisted of 20 rice clumps, resulting in a total of 100 rice clumps observed per field, following the method described by (13). Insect sampling was performed using three methods: yellow sticky traps, light traps, and sweep nets. The traps were deployed in all five observation plots within each field. In each plot, four yellow sticky traps (25 × 20 cm) were positioned according to the cardinal directions and attached to poles at a height of 100 cm. The traps were installed in the morning and left in the field for 24 hours. Light traps were set up by mounting a light source on a pole at a height of 100 cm, with a distance of 50 cm between the light source and the collection basin. Light traps were deployed at 5:00 PM and retrieved at 7:00 AM the following morning. Sweep-net sampling was conducted by sweeping the rice canopy in the morning and afternoon.

Insect sampling was performed at seven-day intervals throughout the study period. Collected insect specimens were transferred into vials containing 70% ethanol for preservation. Each vial was labeled with the sampling date and collection method before being transported to the laboratory for further identification.

2.3 Insect Identification

Insects were identified based on their morphological characteristics, which were documented using a smartphone camera equipped with a macro lens. The observed morphological traits were compared with insect identification guides and relevant scientific literature to determine their taxonomic identities. The specimens were subsequently classified according to the taxonomic levels at which they could be reliably identified. The number of individuals in each taxonomic group was recorded based on sampling location, collection method, and observation period. These data were used to analyze the taxonomic composition, abundance, and temporal population dynamics of insect pests in the two study fields.

2.4 Data Analysis

Data were analyzed using descriptive quantitative methods to characterize the insect pest community structure in organic and conventional rice agroecosystems. The ecological parameters analyzed included the Shannon–Wiener diversity index (H′), Margalef species richness index (DMg), Pielou species evenness index (E), and Berger–Parker dominance index (D). The equations used to calculate each index are presented in Table 2. Data processing and analysis were performed using Microsoft Excel and RStudio. The results are presented in tables and figures to describe and compare patterns of insect pest community structure in the two study fields throughout the observation period.

Table 2: Ecological indices used to analyze insect pest community structure

No.	Indeks	Rumus	Referensi
1	Shannon–Wiener diversity index (H′)	$H' = -\sum pi \ln pi.$	(14)
2	Margalef species richness index (D_mg)	$D_{mg}\ \frac{S-1}{ln.N}$	(15)
3	Pielou evenness index (E)	$E\ \frac{H'}{ln.S}$	(16)
4	Berger–Parker dominance index (D)	$D\ \frac{Nmax}{N}$	(17)

3 RESULTS

3.1 Abundance of Phytophagous Insects in Organic and Conventional Rice Agroecosystems

The abundance of phytophagous insects in organic and conventional rice agroecosystems varied among species. Overall, the organic agroecosystem recorded a higher total abundance of 2,758 individuals than the conventional agroecosystem, which recorded 2,467 individuals, while both systems had the same species richness, with 10 species each. *Nephotettix virescens* was the most abundant species in both agroecosystems, with 1,375 individuals in the organic system and 1,266 individuals in the conventional system. In contrast, *Oxya chinensis* and *Atractomorpha crenulata* were more abundant in the conventional agroecosystem than in the organic agroecosystem (Table 3).

Table 3: Phytophagous insect abundance in organic and conventional rice agroecosystems

Order	Family	Species	Agroekosistem	
			Organic	Convensional
Hemiptera	Alydidae	*Leptocorisa oratorius*	244	127
	Cicadellidae	*Nephotettix virescens*	1375	1266
	Delphacidae	*Nilaparvata lugens*	337	306
	Pentatomidae	*Nezara viridula*	70	29
Lepidoptera	Crambidae	*Scirpophaga incertulas*	156	131
	Nymphalidae	*Melanitis leda*	48	32
Orthoptera	Pyrgomorphidae	*Atractomorpha crenulata*	100	145
	Acrididae	*Locusta migratoria*	97	70
	Acrididae	*Oxya chinensis*	302	343
	Acrididae	*Trimerotropis pallidipennis*	29	18
Total Individuals			2758	2467
Total Species			10	10

The ecological indices of insects in the organic and conventional rice agroecosystems showed relatively similar values (Figure 1). The Shannon diversity index was higher in the organic agroecosystem (1.67) than in the conventional agroecosystem (1.60). In contrast, the Margalef species richness index was slightly higher in the conventional agroecosystem (1.15) than in the organic agroecosystem (1.14). The Pielou evenness index was also higher in the organic system (0.73) than in the conventional system (0.69), whereas the Simpson dominance index was slightly higher in the conventional system (0.20) than in the organic system (0.19). Overall, the organic agroecosystem exhibited higher Shannon diversity and Pielou evenness indices, while the conventional agroecosystem showed slightly higher Margalef species richness and Simpson dominance indices. However, the differences in index values between the two cultivation systems were relatively small.

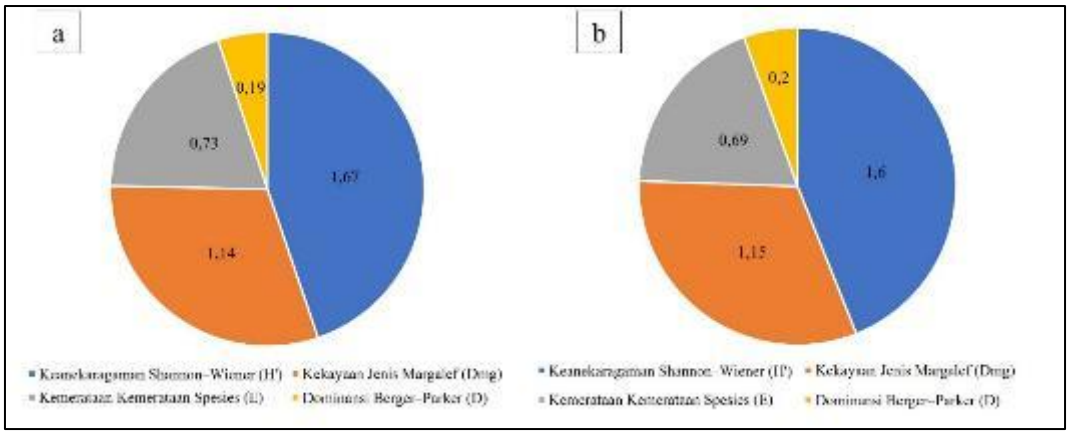


Figure 1: Insect ecological indices in rice agroecosystems: (a) organic rice agroecosystem and (b) conventional rice agroecosystem.

3.2 Population Fluctuations and Interspecific Associations of Phytophagous Insects

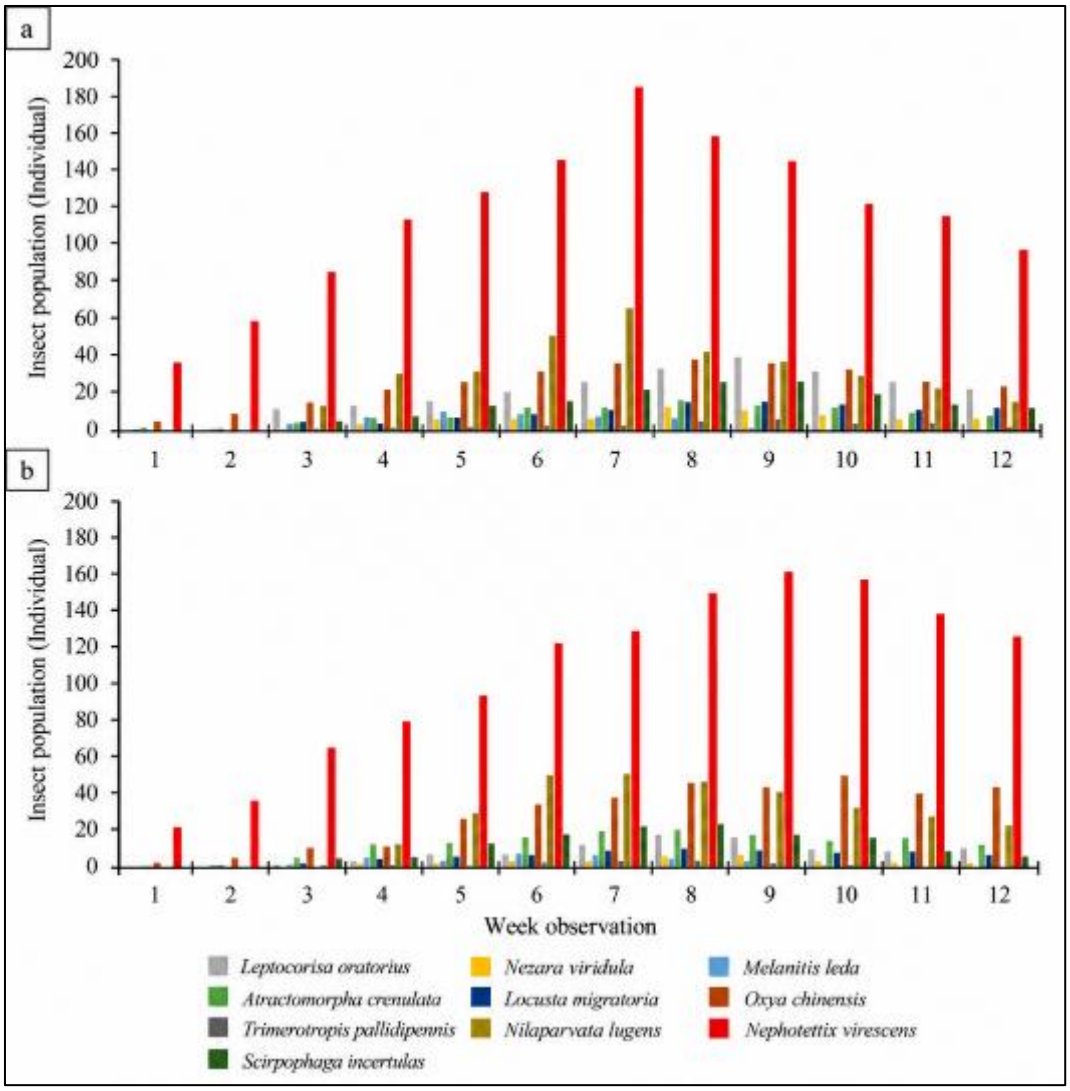


Figure 2: Population fluctuations of phytophagous insects across sampling weeks: (a) organic rice agroecosystem and (b) conventional rice agroecosystem.

The abundance of phytophagous insects fluctuated differently between the organic and conventional rice agroecosystems (Figure 2). In the organic field, total abundance increased from 41 individuals in the first week to a peak of 375 individuals in the seventh week, before declining to 196 individuals in the twelfth week. In the conventional field, abundance increased from 23 individuals to a peak of 323 individuals in the eighth week, followed by a decline to 226

individuals at the end of the observation period. These patterns were primarily driven by *Nephotettix virescens*, which reached its highest abundance in the seventh week in the organic field (183 individuals) and in the ninth week in the conventional field (160 individuals). In contrast, *Oxya chinensis* was more abundant in the conventional field, reaching a peak of 49 individuals in the tenth week, compared with 38 individuals in the organic field during the eighth week. These differences indicate that peak abundance and population fluctuation patterns varied among species and between the two cultivation systems.

Spearman's rank correlation matrix showed that interspecific associations among phytophagous insects in both organic and conventional rice agroecosystems were predominantly positive, although the strength of these associations varied among species (Figure 3). In the organic agroecosystem, the strongest positive correlations were observed between *L. oratorius* and *N. virescens* and between *L. oratorius* and *T. pallidipennis* (ρ = 0.98). In contrast, the strongest negative correlation was found between *L. oratorius* and *M. leda* (ρ = −0.45). In the conventional agroecosystem, the strongest positive correlation was identified between *L. oratorius* and *L. migratoria* (ρ = 0.98), whereas several species pairs exhibited correlations close to zero, including *N. virescens–M. leda* (ρ = 0.05) and *M. leda–O. chinensis* (ρ = −0.04). The differences in the species pairs exhibiting the strongest correlations indicate variation in interspecific abundance association patterns between the two cultivation systems, although positive correlations predominated in both.

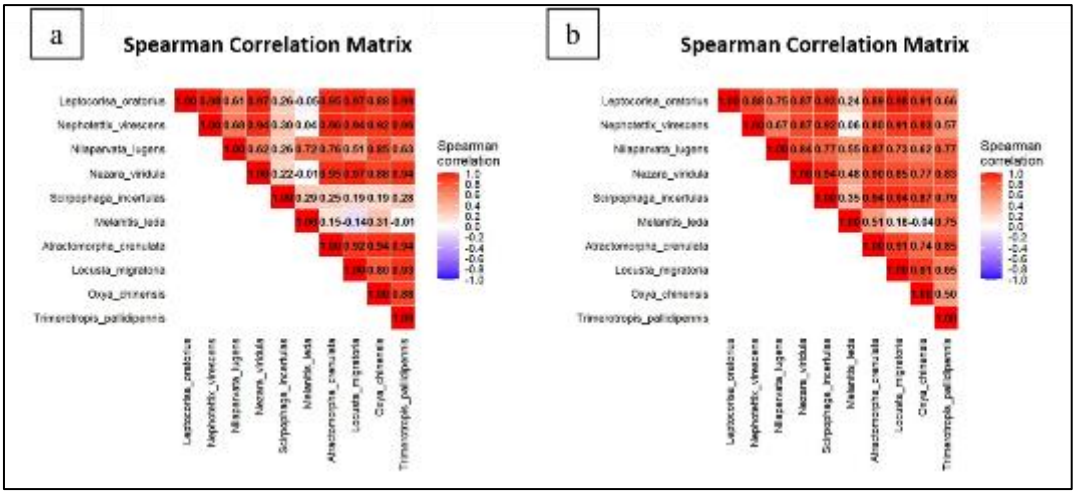


Figure 3: Spearman's correlation matrix of phytophagous insect species. (a) Organic rice agroecosystem and (b) conventional rice agroecosystem. The correlation coefficient (ρ) indicates the direction and strength of interspecific abundance associations; red indicates positive correlations, whereas blue indicates negative correlations.

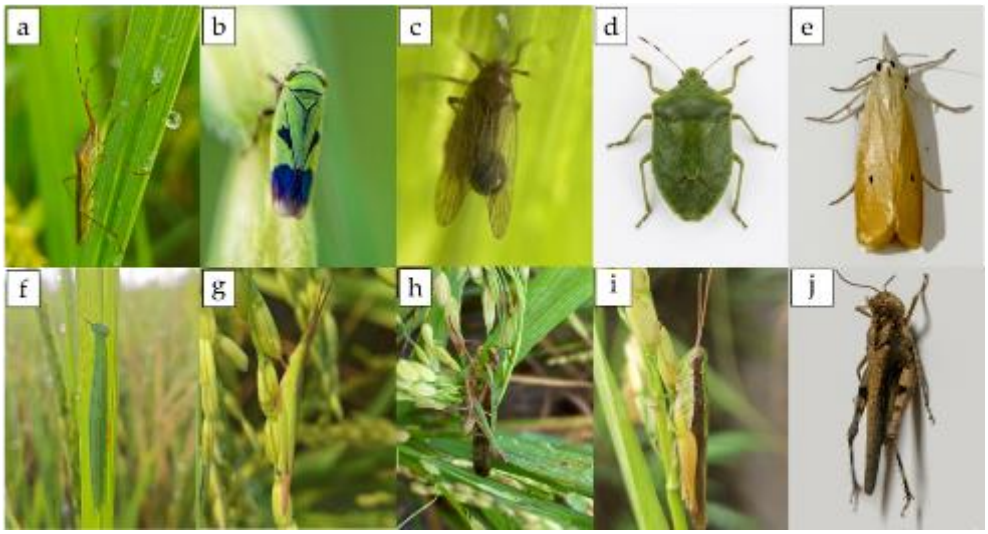


Figure 4: Phytophagous insects recorded in organic and conventional rice agroecosystems. a) Leptocorisa oratorius, b) Nephotettix virescens, c) Nilaparvata lugens, d) Nezara viridula, e) Scirpophaga incertulas, f) Melanitis leda, g) Atractomorpha crenulate, h) Locusta migratoria, i) Oxya chinensis, j) Trimerotropis pallidipennis

Phytophagous insects recorded in the rice agroecosystems exhibited morphological variation and included insects with both piercing-sucking and chewing mouthparts (Figure 4). The piercing-sucking group included *L. oratorius*, *N. virescens*, *N. lugens,* and *N. viridula*. In addition, the chewing group comprised grasshoppers belonging to the order Orthoptera and lepidopteran larvae, which have the potential to damage rice plant tissues.

4 DISCUSSION

The abundance of phytophagous insects in organic and conventional rice agroecosystems differed in terms of the number of individuals but not in species richness. Total abundance in the organic field reached 2,758 individuals, exceeding that in the conventional field (2,467 individuals), whereas both cultivation systems supported the same number of species (10 species). This pattern was associated with the dominance of *Nephotettix virescens*, which accounted for 1,375 individuals in the organic field and 1,266 individuals in the conventional field. The high abundance of green leafhoppers in both fields indicates that this species was a major component of the observed phytophagous insect community. Nevertheless, the higher abundance recorded in the organic field does not necessarily indicate greater susceptibility of this system to pest infestation (18). Insect responses to cultivation systems may vary depending on species identity, geographical conditions, and the management practices implemented. Organic rice cultivation can enhance arthropod diversity; however, its effects on pest and natural enemy abundance are not necessarily consistent across agroecosystems. Therefore, the higher insect abundance observed in the organic field does not, by itself, demonstrate an increased risk of pest infestation under this cultivation system (9)

Differences in community structure were also reflected in the ecological indices, although the differences in their values were relatively small. The Shannon–Wiener diversity index was higher in the organic field (1.67) than in the conventional field (1.60). Similarly, the Pielou evenness index was higher in the organic field (0.73) than in the conventional field (0.69), whereas the Margalef species richness index was slightly higher in the conventional field (1.15) than in the organic field (1.14). These patterns suggest that the differences in species diversity between the two agroecosystems were more closely associated with the distribution of individual abundance among species than with species richness, particularly given the predominance of *N. virescens* in both communities. Meanwhile, the relatively similar dominance index values (0.20 in the conventional field and 0.19 in the organic field) indicate comparable levels of dominance by the most abundant species in both agroecosystems. These findings are consistent with previous research showing that arthropod community composition along the edges of organic and conventional rice fields did not always differ, although crop growth stages could contribute to variations in community structure(10).

Population fluctuations of phytophagous insects may be associated with changes in rice plant conditions during the transition from the vegetative to the reproductive and grain-maturation stages. Total insect abundance peaked in the seventh week in the organic field (375 individuals) and in the eighth week in the conventional field (323 individuals). *Nephotettix virescens* was the dominant species, reaching peak abundances of 183 individuals in the seventh week in the organic field and 160 individuals in the ninth week in the conventional field. Meanwhile, *O. chinensis* reached its highest abundance in the tenth week in the conventional field (49 individuals). Differences in peak timing indicate that population dynamics varied among species, potentially reflecting differences in their responses to plant conditions and food resource availability. During the reproductive stage, panicle formation and grain development may increase host suitability for certain insects, particularly the rice ear bug (*L. oratorius*), which feeds on developing grains. *Leptocorisa oratorius* is an important pest during the reproductive stage of rice because its feeding activity on developing grains can affect grain quality and yield (19). Peak populations of this pest have also been reported to coincide with the milky stage of grain development, indicating the importance of grain development in shaping its population dynamics (20). Differences in peak abundance indicate that phytophagous insect population dynamics varied among species across the two agroecosystems. These variations may be associated with species-specific responses to plant conditions, food resource availability, and field management practices. In this context, rice plant development may be an important factor influencing population dynamics, particularly through changes in host suitability as a habitat and food resource.

The Spearman correlation matrix indicated that changes in the abundance of several phytophagous insect species tended to follow similar patterns; however, the species pairs exhibiting the strongest correlations differed between the organic and conventional agroecosystems. In the organic field, the strongest correlations were observed between *L. oratorius* and *N. virescens* and between *L. oratorius* and *T. pallidipennis* ($\rho = 0.98$), whereas in the conventional field, the strongest correlation was identified between *L. oratorius* and *Locusta migratoria* ($\rho = 0.98$). These findings indicate that changes in *L. oratorius* abundance were associated with different abundance patterns among other species in the two agroecosystems. (21) explained that associations among phytophagous insects may be related to biotic and abiotic factors that simultaneously influence population dynamics. However, positive correlations do not demonstrate direct interspecific interactions, as such patterns may also arise from shared responses to environmental conditions (22). Therefore, the differences in correlation patterns indicate variation in interspecific abundance associations between the two fields, although the underlying factors remain undetermined.

5 CONCLUSIONS

The organic rice agroecosystem supported a higher abundance of phytophagous insects (2,758 individuals) than the conventional agroecosystem (2,467 individuals), although both systems had the same species richness (10 species). Species diversity and evenness were higher in the organic field, whereas species richness was slightly higher in the conventional field. *Nephotettix virescens* was the most abundant species in both cultivation systems, with peak total insect abundance occurring in the seventh week in the organic field and the eighth week in the conventional field. These findings indicate that phytophagous insect responses varied among species and across sampling periods, highlighting the importance of considering species-specific population dynamics when developing effective pest management strategies.

STATEMENTS ON COMPLIANCE WITH ETHICAL STANDARDS

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Disclosure of conflict of interest

The authors declare no conflict of interest.

REFERENCES

[1] Fukagawa NK, Ziska LH. Rice: importance for global nutrition. J Nutr Sci Vitaminol (Tokyo). 2019;65:S2–3.

[2] Susanto A, Hidayah S, Fadillah A. Optimasi Alokasi Lahan Padi dan Cabai Merah dengan Program Linear. J Ilm Mat. 2026;7(3):637–50.

[3] Reganold JP, Wachter JM. Organic agriculture in the twenty-first century. Nat Plants [Internet]. 2016;2(2):1–8. Available from: http://dx.doi.org/10.1038/nplants.2015.221

[4] Meemken EM, Qaim M. Organic Agriculture, Food Security, and the Environment. Annu Rev Resour Econ. 2018;10:39–63.

[5] Wahyudi D, Ardiansyah. The transition toward sustainable organic food systems in Indonesia: A case study of organic rice. Sustainability. 2020;12(10):1–15.

[6] Savary S, Willocquet L, Pethybridge SJ, Esker P, McRoberts N, Nelson A. The global burden of pathogens and pests on major food crops. Nat Ecol Evol. 2019;3(3):430–9.

[7] Puspito AN, Rozzita N, Tigara MRN, Putra SID, Purnamasari I, Hartatik S, et al. Molecular screening of local Indonesian rice to identified resistant varieties against brown planthopper (*Nilaparvata lugens*) attacks. Biodiversitas. 2023;24(10):5503–12.

[8] Statistics Indonesia. Area Harvested and Rice Production in Indonesia 2022: Results of the Agricultural Statistics Data Collection Activities Integrated with the Area Sample Frame Method. Katalog: 5203031. 2023.

[9] Gong S, Zhou X, Zhu X, Huo J, Faghihinia M, Li B, et al. Organic rice cultivation enhances the diversity of above-ground arthropods but not below-ground soil eukaryotes. Agric Ecosyst Environ [Internet]. 2023;347(January):108390. Available from: https://doi.org/10.1016/j.agee.2023.108390

[10] Koh CN, Chiu MC, Jaung LM, Lu YJ, Lin HJ. Effects of farming systems on insect communities in the paddy fields of a simplified landscape during a pest-control intervention. Zool Stud. 2021;60:1–8.

[11] Wu J, Ge L, Liu F, Song Q, Stanley D. Pesticide-induced planthopper population resurgence in rice cropping systems. Annu Rev Entomol. 2020;65:409–29.

[12] Yuan X, Zhou WW, Jiang YD, Yu H, Wu SY, Gao YL, et al. Organic Regime Promotes Evenness of Natural Enemies and Planthopper Control in Paddy Fields. Environ Entomol. 2019;48(2):318–25.

[13] Wagiyanti W, Hamidson H, Suwandi S. Intensity and Incidence of Pest Disease Attacks on Rice Plants in Enggal Rejo Village, Air Salek Subdistrict. J Glob Sustain Agric. 2024;4(2):144.

[14] Shannon CE. A Mathematical Theory of Communication. Bell Syst Tech J. 1948;27(3):379–423.

[15] Mokam DG, Djiéto-Lordon C, Bilong CFB, Brunet J. Patterns of species richness and diversity of insects associated with cucurbit fruits in the southern part of Cameroon. J Insect Sci. 2014;14(1).

[16] Pielou EC. Species-diversity and pattern-diversity in the study of ecological succession. J Theor Biol. 1966;10(2):370–83.

[17] Berger WH, Parker FL. Diversity of planktonic foraminifera in deep-sea sediments. Science (80-). 1970;168(3937):1345–7.

[18] Sorgog K, Tanaka K, Baba YG. Macro-scale perspectives in conservation biological control: latitudinal differences in the effects of organic farming on insect pests and natural enemies in rice paddy ecosystems. Agric Ecosyst Environ [Internet]. 2023;357(July):108689. Available from: https://doi.org/10.1016/j.agee.2023.108689

[19] Aryal A, Aryal S, Khanal R, Sapkota U, Ghimire P, Pandey P, et al. Evaluation of biorational pesticides for managing rice earhead bug, *Leptocorisa oratorius* (Fabricius) [Hemiptera: Alydidae] in spring rice. Cogent Food Agric [Internet]. 2026;12(1). Available from: https://doi.org/10.1080/23311932.2026.2668188

[20] Sarangi S, Patel DS, Priya P, Dey S, Chandrakar PD, Kumar P, et al. Seasonal Incidence, Field Screening of Local Landraces, and Biochemical Basis of Resistance in Rice Against Paddy Earhead Bug, *Leptocorisa Oratorius* (Fabricius) (Hemiptera: Alydidae). Genet Mol Res. 2026;25:1–14.

[21] Lertzman-Lepofsky G, Dolezal AJ, Waters MT, Fuster-Calvo A, Black EN, Flaman S, et al. Temporal changes in taxon abundances are positively correlated but poorly predicted at the global scale. Ecography (Cop). 2025;2025(3):1–14.

[22] Blanchet FG, Cazelles K, Gravel D. Co-occurrence is not evidence of ecological interactions. Ecol Lett. 2020;23(7):1050–63.