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Research Article

Diversity of Beneficial Insect in Corn Plantation at West Sumatra

Martinus Abuzar[1)]*, Ujang Khairul[2)], & Hasmiandy Hamid[2)]

[1)]Postgraduate Program of Pests and Plant Diseases, Faculty of Agriculture, Andalas University
[2)]Study Program of Plant Protection, Faculty of Agriculture, Andalas University
Limau Manis, Padang, West Sumatra, 25163 Indonesia

**Corresponding author. E-mail: martinusabuzar03@gmail.com*

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ABSTRACT

Corn is one of Indonesia's agricultural products with economic, strategic value and many potential to develop, such as carbohydrates and protein sources. There are two types of beneficial insects in corn production: predators and parasitoids. This study aims to identify the diversity of beneficial insects in corn plantations. This study was conducted from May to September 2019 in four different locations across West Sumatra, namely Padang Pariaman, West Pasaman, Pesisir Selatan, Solok Regencies. Identification of beneficial insects was made in Entomology Laboratory, Faculty of Agriculture, Andalas University. This study adopted a purposive sampling method using 20 sweeps of sweep nets, following a transect line in cornfields. The result showed five orders, 34 families, 101 morphospecies, and 747 beneficial insects in all the locations. The diversity in each location varied from high, medium, and low. In all the areas, the diversity index was high, with the criteria of ≥ 2.90, implying that the condition of the community structure was very stable. From the evenness index analysis, three locations were classified as high, and the other one was moderate. These three sites were Padang Pariaman, West Pasaman, and Solok, with criteria of ≥ 0.90 and very stable distribution conditions.

Keywords: beneficial insect; corn; diversity index

INTRODUCTION

Corn is one of Indonesia's agricultural products with economic, strategic value, and potential to develop, such as main carbohydrates and protein sources. Besides animal feed, it has many other benefits, such as raw materials for industrial and household purposes. Its production in 2014 was 19 million tons and increased in 2015 to 19.6 million tons. This trend of increasing corn production continued in 2016 to 23.6 million tons. In 2017, it reached 28.9 million tons and rose again to 30 million tons in 2018. West Pasaman is a significant corn production center in West Sumatra that yields up to 284,526 tons, followed by Pesisir Selatan with 108,894 tons, Padang Pariaman with 1,630 tons, Solok Regency with 1,630 tons (*Badan Pusat Statistik*, 2019).

Total corn production is affected by insects in surrounding areas. The relationship between insects and plants is one of the biotic interactions in a community, and these biotic interactions can be positive or negative. The interaction is a form of survival to maintain existence (Pieterse & Dicke, 2007). According to Bronstein *et al.* (2006), a reciprocal relationship with plants is divided into several groups, including insects eating plants (phytophagous insects), plants eating insects (entomophagy plants), plants causing diseases to insects (entomophthora plants), plants pollinated by insects (entomophilous plants), and insects may assist plant pathogens dispersion (vectors).

Insect inventory is a technique to determine the species living in a certain area. It is necessary to identify insects and calculate their diversity.

Identification needs to be done to determine insect species names and their diversity. According to Hamid *et al.* (2017), cultivation techniques and cropping patterns affect the diversity level by altering insects' living conditions on and around the agricultural land. Diversity is almost similar to the richness of its species, and both are closely related. The variables that need to be calculated in this study are Diversity (H'), Evenness, and Species Similarity Index.

According to Kaleb *et al.* (2015), there are two beneficial insects in corn planting: predators and parasitoids. Rahayu *et al.* (2017) stated that beneficial insects might also include these organisms are also pollinators, detritivores, and fungivores. Insects have many roles and species, and each has a different ecological function. Predators hunt and prey on other insects, while parasitoid is relatively smaller than their prey.

Insects' role in corn production needs to be identified to increase its literature and usefulness for agriculture in the future. Therefore, this study aims to know the diversity of beneficial insects in corn plantations in West Sumatra; and was followed by determining the diversity, evenness, and similarity index of their benefits in West Sumatra. Therefore, this research is recommended for agricultural development and conservation of natural insect predators.

MATERIALS AND METHODS

Time and Location

This research was conducted from May to September 2019 at conventional corn-planting center in West Sumatra, namely Padang Pariaman (0°42'55.5" S, 100°16'34.4" E), West Pasaman (0°1'57.9" S, 99°51'53.3" E), Pesisir Selatan (0°42'6.3" S, 100° 33'56.3" E), and Solok Regency (1° 46'33.8" S, 100° 46'55.5" E) (Table 1). The insect identification was carried out at the Entomology Laboratory, Faculty of Agriculture, Andalas University. Insect collection was carried out twice during the vegetative maize phase (15–25 days) and generative (75–95 days). Insects were collected using a sweep net, and insects were collected by using the double swing technique 20 times. Collection was done by following a transect line in the cornfields. Collected insects were placed into sample bottles containing 96% alcohol and taken to the laboratory to be identified by comparing to selected literature (Borror *et al.*, 1996).

Insect Identification

The identified insects were grouped based on their orders, families, and morphospecies, then were calculated according to their locations. After identification, their roles were determined based on their function within the agricultural fields. This data was required for the Diversity Index measurement using the Shannon-Wiener model and the Average Index assessment using the Simpson evenness model.

Data Analysis

The beneficial insect diversity was measured using the Shannon-Wiener diversity index (Krebs, 2000) as follows:

$$H' = - \Sigma pi \ln pi$$

$$pi = \frac{n}{N}$$

H′= Shannon-Wiener diversity index; pi = proportion of the i-th species individual in the community; ln = logarithm of nature; n = the abundance of the i-th species individual; N = total individuals of all species.

Species evenness was the proportion of each organism in a community or ecosystem. It was measured using the Simpson evenness index, which assessed the proportion of each species in a population at a specific place and time. The Simpson's evenness index used the formula according to Krebs (2000):

$$e = \frac{H}{\log S}$$

e = Simpson's evenness index; H = Shannon-Wiener diversity index; S = proportion of species in the community.

The evenness value ranged from zero to one. When the value was close to zero, the insect's distribution in an ecosystem was not even, and vice versa (Elkie *et al.,* 1999).

Table 1. Description of the research location

Location/Coordinates	Observation parameters	Description
Padang Pariaman	The area of land observed	2 ha
0°42′55.5″ S,	The observed plant age	15 and 60 days
100°16′34.4″ E	Vegetation around	Coconut and wild plants
	Fertilizer Utilization	NPK
	Pesticides Utilization	Yes
	Pests that experienced attacked	*Spodoptera litura* and leafhoppers
West Pasaman	The area of land observed	7 ha
0°1′57.9″ S	The observed plant age	15 and 60 days
99°51′53.3″ E	Vegetation around	Rice and chili
	Fertilizer Utilization	Urea and NPK
	Pesticides Utilization	Yes
	Pests that experienced attacked	*Spodoptera litura*, leafhoppers, and lady beetles
Pesisir Selatan	The area of land observed	3.5 ha
0°42′6.3″ S	The observed plant age	25 and 65 days
100°33′56.3″ E	Vegetation around	boconut and Banana
	Fertilizer Utilization	NPK and Urea
	Pesticides Utilization	Yes
	Pests that experienced attacked	Grasshoppers, planthoppers, fruit borer caterpillars, rats
Solok	The area of land observed	2 ha
1°46′33.8″ S	The observed plant age	15 and 60 days
100°46′55.5″ E	Vegetation around	Shallot
	Fertilizer Utilization	Urea and Ponska
	Pesticides Utilization	Yes
	Pests that experienced attacked	Aphid

RESULTS AND DISCUSSION

The Number of Beneficial Insects.

The number of beneficial insects found in all locations was 747 individuals, classified into 101 morphospecies, 34 families, and five orders. The research data included five functional roles of insects: parasitoid, predator, pollinator, detritivore, and fungus (Table 2). One of the most commonly found order was Hymenoptera. Hymenoptera has many vital roles in ecosystems, namely parasitoids, predators, pollinators, detritivores, and phytophages (Anderson *et al.*, 2011; Ikhsan *et al.*, 2020). Hymenoptera dominates parasitoid species by about 80% of parasitoids belonging to this order (Quicke, 1997; Saputra *et al.*, 2017).

The following were the families of predatory species found in the order of Coleoptera (3), Diptera (3), Hemiptera (1), Hymenoptera (2), and Odonata (2). Sixteen families of the order Hymenoptera act as parasitoids and pollinators. There are four families of the order Diptera identified as detritivores and fungivores. The results showed that parasitoids were the beneficial function found from all locations, followed by species with roles as predators. Beneficial insects were generally distributed evenly based on the data obtained in Padang Pariaman (42 morphospecies and 111 individuals), in West Pasaman (66 morphospecies and 171 individuals), in Pesisir Selatan (67 morphospecies and 304 individuals), and Solok (69 morphospecies and 161 individuals).

Table 2. Role and numbers of beneficial insects at all observation sites

Role	Order	Family	Padang Pariaman		West Pasaman		Pesisir Selatan		Solok	
			JS	JI	JS	JI	JS	JI	JS	JI
Parasitoid	**Hymenoptera**	Aphelinidae	1	2	1	1	1	3	1	1
		Braconidae	3	6	4	9	3	5	4	10
		Ceraphronidae	2	4	5	8	5	10	6	9
		Chalcididae	1	1	2	3	2	3	2	1
		Diapriidae	0	0	0	0	0	0	1	1
		Encyrtidae	1	1	1	1	1	5	2	2
		Eucoilidae	1	1	2	5	2	4	2	3
		Eulophidae	7	10	8	12	11	19	7	12
		Evaniidae	0	0	0	0	0	0	2	1
		Hymenoptera A	0	0	1	1	0	0	0	0
		Ichneumonidae	1	1	0	0	1	1	2	3
		Mymaridae	1	1	0	0	1	2	2	4
		Platygastridae	5	8	7	11	11	21	8	12
		Pteromalidae	2	2	2	2	4	7	1	1
		Scelionidae	2	6	1	6	3	4	2	7
		Tricogrammatidae	2	3	2	3	2	4	2	4
		Total	29	46	36	62	47	88	44	71
Predator	**Coleoptera**	Carabidae	2	4	5	12	2	7	5	8
		Coccinellidae	2	14	4	16	3	7	3	21
		Elateridae	0	0	1	1	0	0	0	0
	Diptera	Culicidae	0	0	0	0	0	0	1	1
		Dolichopodidae	0	0	0	0	0	0	1	2
		Therevidae	0	0	1	2	0	0	0	0
	Hemiptera	Reduviidae	1	2	3	4	2	8	3	4
	Hymenoptera	Formicidae	4	34	7	59	6	65	5	37
		Pompilidae	0	0	1	1	0	0	1	1
	Odonata	Coenagrionidae	0	0	2	1	1	2	0	0
		Gomphidae	0	0	2	2	1	1	1	1
		Total	9	54	26	98	15	90	20	75
Pollinator	**Hymenoptera**	Halictidae	2	9	1	3	2	3	2	6
		Hymenoptera B	0	0	1	1	0	0	0	0
		Vespidae	1	1	1	2	1	1	1	1
		Total	3	10	3	6	3	4	3	7
Detritivore	**Diptera**	Anisopodidae	0	0	0	0	1	1	1	2
		Cecidomyiidae	0	0	1	1	0	0	0	0
		Lauxaniidae	1	1	0	0	1	1	1	1
		Total	1	1	1	1	2	2	2	3
Fungivore	**Diptera**	Mycetophilidae	0	0	0	4	0	120	0	5
		Total	0	0	0	4	0	120	0	5
		Total	42	111	66	171	67	304	69	161

Information: JS = Number of species, JI = Number of individuals

Beneficial Insect Diversity

The diversity in each location varied from high, medium, to low. In all research locations, the diversity index was high (≥ 2.90), indicating that conditions of community structure were very stable (Table 3). The evenness index in the research locations found that three locations were high, and the other was moderate. Padang Pariaman, West Pasaman, and Solok, with criteria of ≥ 0.90, indicated to very stable distribution. At the same time, those with moderate conditions were found in Pesisir Selatan with criteria of 0.69 and a more stable distribution. Insect diversity can be affected by agroecosystem conditions. In addition, climatic factors in an agroecosystem can also affect the behavior and number of insect populations (Rubiana, 2014).

Table 3. The number of morphospecies, individuals, diversity index, and evenness index

Location	S	N	H′	E
Padang Pariaman	42	111	3.40	0.91
West Pasaman	66	171	3.79	0.90
Pesisir Selatan	67	304	2.90	0.69
Solok	69	161	3.88	0.92

Information: S = number of morphospecies, N = number of individuals, H′ = diversity index, E = evenness index.

Based on this research, it was found that five insect orders were beneficial in corn plantations, either as natural predators or for weathering plant debris. Generally, the Hymenoptera order had parasitoid role, while the Coleoptera functions as a predator. According to Atmowidi *et al.* (2001), the order of the Diptera group acts as a destroyer of fungi and agricultural crop residues, which means that it has an important economic value in agriculture. Also, it acts as a parasitoid. However, in this study, there were no parasitic insects from this order.

Environmental conditions significantly affected the total species, individuals, diversity, and evenness of insects. Conditions such as rainfall, length of exposure, and varieties of plants also affected insect diversity. Natural enemies, both parasitoids and predators, were influenced by the presence of hosts, which also need plants as a source of food. Therefore, the three components are related to one another. According to Hamid *et al.* (2003), the factor affecting natural enemies is the season. When it is suitable for host development, then natural enemies also increase. During the rainy season, the parasitoids' parasitation was higher than the predation rate of predators because host insects were less active during rain events. Therefore, parasitoids could quickly find their host. Yaherwandi *et al.* (2007) reported that habitat diversity and agricultural landscape structure could affect the richness, diversity, and even distribution of Hymenoptera parasitic species in the Cianjur watershed.

Besides environmental conditions, the most determining factor was also the type of plant grown. Corn is high in carbohydrates and is most preferred by pests. Therefore, the organisms that attack this plant also invite natural enemies to find their hosts. According to Rondo *et al.* (2016), corn plants have very high pest attack level because they were very popular with pests, such as grasshoppers, seed flies, cob flies, and armyworms, which attack the leaves, stems, shoots, and cobs; therefore, significantly decreasing yield. Insects took shelter in plants around the corn crop and eventually bred there, increasing the diversity and evenness of natural enemies and other beneficial organisms. The diversity and abundance of Hymenoptera in an agricultural habitat can be influenced by the landscape structure and habitat conditions (Susilawati, 2016; Ikhsan *et al.*, 2021). Lizmah (2015) reported that the abundance of Hymenoptera parasitoid in cucumber cultivation was higher in complex landscapes than in simple landscapes.

CONCLUSION

Hymenoptera, Coleoptera, Diptera, Hemiptera, and Odonata were orders of beneficial insects found in the corn plantation at West Sumatra. Furthermore, 747 individuals of beneficial insects were found and classified into 101 morphospecies and 34 families. The diversity of the insects in all the locations was high, with very stable community structures. The evenness of beneficial insects was generally classified as high with a very stable distribution. The factors affecting beneficial insect diversity were environmental conditions, hosts, plant types, and planting features.

LITERATURE CITED

Anderson, A., McCormack, S., Helden, A., Sheridan, H., Kinsella, A., & Purvis, G. (2010). The Potential of Parasitoid Hymenoptera as Bioindicators of Arthropod Diversity in Agricultural Grasslands. *Journal of Applied Ecology*, *48*(2), 382–390. https://doi.org/10.1111/j.1365-2664.2010.01937.x

Atmowidi, T., Prawasti, T.S. Utomo, S., & Kurniawan, Y. (2001). Keanekaragaman Diptera (Insecta) di Gunung Kendeng dan Gunung Botol, Taman Nasional Gunung Halimun, Jawa Barat. *Berita Biologi*, 5(6), 773–779. Retrieved from https://e-journal.biologi.lipi.go.id/index.php/berita_biologi/article/view/1084

Badan Pusat Statistik. (2019). *Produksi Jagung Menurut Provinsi (Ton)*. Retrieved from http://bps.go.id.

Borror, Donald J., Charles A. Triplehorn, & Norman F. Johnson. (1996). *Pengenalan Pelajaran Serangga*. 6th ed. edited by S. Partosoedjono and M. D. Brotowidjoyo. Yogyakarta, Indonesia: Gadjah Mada University Press.

Bronstein, J.L., Alarcón, R., & Geber, M. (2006). The Evolution of Plant-Insect Mutualisms. *New Phytologist, 172*(3), 412-428.

Elkie, P.C. Rempel, R.S. & Carr, A.P. (1999). *Patch Analyst User's Manual: A Tool for Quantifying Landscape Structure*. 2nd ed. Ontario, Canada: Ontario Ministry of Natural Resources, Boreal Science, Northwest Science & Technology.

Hamid, H., Buchori, D., & Triwidodo, H. (2003). Keanekaragaman Parasitoid dan Parasitisasinya pada Pertanaman Padi di Kawasan Taman Nasional Gunung Halimun. *Hayati*, *10*(3), 85–90.

Hamid, H., & Martinius. (2017). Keanekaragaman Serangga Air di Sawah Konvensional dan Organik di Kota Padang. *JPT: Jurnal Proteksi Tanaman (Journal of Plant Protection)*, *1*(2), 68–78. https://doi.org/10.25077/jpt.1.2.68-78.2017

Ikhsan, Z., Hidrayani, Yaherwandi, & Hamid, H. (2020). The Diversity and Abundance of Hymenoptera Insects on Tidal Swamp Rice Field in Indragiri Hilir District, Indonesia. *Biodiversitas: Journal of Biological Diversity*, *21*(3), 1020–1026. https://doi.org/10.13057/biodiv/d210323

Ikhsan, Z., Hidrayani, Yaherwandi, & Hamid, H. (2021). Effectiveness of Sweep Net, Yellow Pan Trap, and Malaise Trap for Sampling Parasitic Hymenoptera on Tidal Swamp Rice. *Aceh Journal of Animal Science*, *6*(2), 62–68. https://doi.org/10.13170/ajas.6.2.18348

Kaleb, R., Pasaru, F., & Khasanah, N. (2015). Keanekaragaman Serangga Musuh Alami pada Pertanaman Bawang Merah (*Allium ascalonicum* L.) yang Diaplikasi dengan Bioinsektisida *Beauveria bassiana* (Bals.-Criv.) Vuill. *Agroland: Jurnal Ilmu-Ilmu Pertanian, 22*(2), 114–122. Retrieved from http://jurnal.untad.ac.id/jurnal/index.php/AGROLAND/article/view/8036

Krebs, C.J. (2000). *Ecological Methodology*. (2nd ed). New York, United States: Benjamin Cummings.

Lizmah, S.F. (2015). *Pengaruh Struktur Lanskap terhadap Keanekaragaman Hymenoptera Parasitika pada Lahan Mentimun* [Master's thesis]. Bogor, Indonesia: Institut Pertanian Bogor.

Pieterse, C.M.J. & Dicke, M. (2007). Plant Interactions with Microbes and Insects: From Molecular Mechanisms to Ecology. *Trends in Plant Science*, *12*(12), 564–569. https://doi.org/10.1016/j.tplants.2007.09.004

Quicke, D.L. (1997). *Parasitic Wasps*. 1st ed. London, United Kingdom: Springer.

Rahayu, G.A., Buchori, D., Hindayana, D., & Rizali, A. (2017). Keanekaragaman dan Peran Fungsional Serangga Ordo Coleoptera di Area Reklamasi Pascatambang Batubara di Berau, Kalimantan Timur. *Jurnal Entomologi Indonesia*, *14*(2), 97–106. https://doi.org/10.5994/jei.14.2.97

Rondo, S.F., Sudarma, I.M., & Wijana, G. (2016). Dinamika Populasi Hama dan Penyakit Utama Tanaman Jagung Manis (*Zea mays saccharata* Sturt) pada Lahan Basah dengan Sistem Budidaya Konvensional serta Pengaruhnya terhadap Hasil di Denpasar-Bali. *Agrotrop: Journal on Agriculture Science, 6*(2), 128–136. Retrieved from https://ojs.unud.ac.id/index.php/agrotrop/article/view/29440

Rubiana, R. (2014). *Pengaruh Transformasi Habitat terhadap Keanekaragaman dan Struktur Komunitas Semut di Jambi* [Master's thesis]. Bogor, Indonesia: Institut Pertanian Bogor.

Saputra, H. M., Maryana, N., & Pudjianto. (2017). Keanekaragaman Hymenoptera Parasitika pada Tipe Ekosistem Berbeda di Bangka Tengah, Kepulauan Bangka Belitung. *Jurnal Hama dan Penyakit Tumbuhan Tropika*, *17*(1), 37–44. https://doi.org/10.23960/j.hptt.11737-44

Susilawati. (2016). *Keanekaragaman dan Kelimpahan Serangga Pengunjung Bunga Mentimun pada Struktur Lanskap Berbeda* [Master's thesis]. Bogor, Indonesia: Institut Pertanian Bogor.

Yaherwandi, Manuwoto, S., Buchori, D., Hidayat, P., & Prasetyo, L.B. (2007). Keanekaragaman Hymenoptera Parasitoid pada Sturuktur Lanskap Pertanian Berbeda di Daerah Aliran Sungai (DAS) Cianjur, Jawa Barat. *Jurnal Hama dan Penyakit Tumbuhan Tropika, 7*(1), 10–20. Retrieved from http://jhpttropika.fp.unila.ac.id/index.php/jhpttropika/article/view/123