InJAR
Indonesian Journal of Agricultural Research

Diversity Index of Insect Species on Sorghum Plantations in Kolam Village, Percut Sei Tuan District, Deli Serdang

Parlindungan Tarihoran, Ameilia Zuliyanti Siregar*, Marheni

Department of Agrotechnology, Faculty of Agriculture, Universitas Sumatera Utara, Indonesia

Abstract. This research aimed to know the diversity of insects of sorghum plantations and the status of insect functions in sorghum plants. The purposive sampling method were done, which used 4 traps, consist of yellow sticky trap, sweep net, pitfall trap and light trap for 8 observations research were done from May to September 2019 at Kolam Village, Percut Sei Tuan District of Deli Serdang Regency, then continue to identified in Pest Laboratory Faculty of Agriculture University of Sumatera Utara, Medan. The results showed that there were 117 individuals insects which consist of 10 orders and 33 families. The highest relative density was 14.74% and the lowest was 0.42% sere recorded, while the highest relative frequency was 4.08% and the lowest was 1.53%. The value of insect diversity index was 3.115 (High), it is mean the diversities of insects varied and the habitat was good for growth of insects. The value of evenness index was 0.891 (high) and richness index was 4.15 (high). The dominant insects recorded from Order of Hymenoptera (Family of Formicidae), continued to Coleoptera (Family of Scarabaeidae; Coccinellidae) are quite diverse in the sorghum plantations. The function status of insects was recorded as herbivores, parasitoids, predators, pollinators and decomposer were determined.

Keywords: diversity, function status, insect, richness, sorghum

Received 06 April 2020 | Revised 09 May 2020 | Accepted 11 July 2020

1. Introduction

Sorghum which is a cereal crop that can provide many benefits including from seed produces flour instead of wheat, of the stem can produce a sap that can be used as sugar and fodder. Sorghum is one type of cereal crop that has great potential to be developed in Indonesia because it has wide spread area of adaptation. These plants are quite tolerant of soil less fertile or degraded soils, so that lands that are less productive or idle land can be cultivated. Sorghum is quite tolerant to drought and waterlogging, to be productive on marginal land and are relatively resistant to pests and diseases [1].

*Corresponding author at: Department of Agrotechnology, Faculty of Agriculture, Universitas Sumatera Utara, Indonesia, Jl. Dr. A. Sofyan No 3 Kampus USU, Medan, 20155, Sumatera Utara, Indonesia

E-mail address: ameiliazuliyanti@gmail.com

In Indonesia, sorghum plants have been cultivated mainly in Java, South Sulawesi, Southeast Sulawesi, West Nusa Tenggara (NTB) and East Nusa Tenggara (NTT). Sorghum producing regions with traditional business patterns are Central Java (Purwodadi, Pati, Demak, Wonogiri), Special Region of Yogyakarta (Gunung Kidul, Kulon Progo), and East Java (Lamongan, Bojonegoro, Tuban, Probolinggo) [2].

In Deli Serdang, it supports the suitability of 7,000 ha of sorghum plantations. Various factors lead to low yield of sorghum, one of which is due to pests. Pests was a problem because damage by eating, shelter or nesting in near of crops. Potential or the ability of these pests damage crops is one of the factors that determine the importance of a pest [3].

Damage to crops caused by insects is determined by the type of insect, the greater the potential damage which is owned by insects the lower the economic value. So that the diversity of species of insects and the potential role advantages and detrimental insects on agricultural ecosystems need to be managed properly [4].

In an ecosystem where sorghum crop insect pests will affect farming activities because it will directly reduce the quality and quantity of product and if the activities do not control of cultivation will suffer losses. Losses will face a variety of factors that affect the growth of plants such as the level of pest attacks, therefore pest control is important. Information about the diversity of insects and their abundance in sorghum plantations is not widely known. Therefore, to know abundance and diversity of sorghum plants needs to be determine for the management and control of sorghum can be done well.

2. Material and Methods

2.1. Time and Location

The study was conducted in sorghum plantations in the Kolam Village, Percut Sei Tuan District, Deli Serdang Regency, Province of Sumatera Utara with altitude of 21 meters above sea level (asl) was carried out from May 2019 to September 2019.

2.2. Materials and Tools

The materials used in this study were the imago insect, water, detergent, plastic transparent, yellow sticky trap, glue, alcohol 70%, and other supporting equipment. The tools used in this study were jars, gauze, sweep net, light trap using emergency lights, pitfall traps using plastic cups, basins, tape, tweezers, scissors, sample vials, syringes, magnifying glass, camera, stereo microscope binocular, identification book of Kalshoven (1981), Sulthoni and Subiyanto (1980).

2.3. Method

The research was used purposive sampling method, a non-probability sample that is selected based on characteristics of a population and the objective of the study. This research was carried

out an area of 27 x 22 m of sorghum plantation. The traps are placed according to 4 cardinal directions and 1 in the middle of the crop. Yellow sticky trap installed by five points and so also *pitfall traps* installed by five points in a rectangle of land and one in the middle. While the use of light traps using emergency lights are used at night in the middle of planting starting at 6:00 pm then taken at 10:00 pm, and for trapping nets (*sweep net*) is used to catch insects that fly in sorghum plantations. Catching insects is carried out starting from the vegetative period of 20 days after germination until the seeds mature physiologically. The trap was set at 8:00 am and the taking of insects was carried out on the 3rd day at 6:00 p.m. with a length of installation of three days per observation. Light trap traps are installed at night once per observation, while sweep net traps are used in the morning and in the afternoon.

The installation of traps was carried out 8 times according to the growth phase of the sorghum plant ie. when the 5th leaf midrib was seen (20 Days of Before Plantation=DBP), the differentiation of the growing point (30 DBP), the appearance of the flag leaf (40 DBP), the bubble leaf midrib (50 DBP), the plant 50% flowering (60 DBP), ripe milk seeds (70 DBP), hardening of the seeds (85 DBP), physiologically mature seeds (95-100 DBP). Insects were caught in traps are taken and counted and separated species. The collected insects are put into a closed sample bottle using tweezers carefully. Identification is done by observing the morphology using a microscope and to find the taxonomy of insects.

2.4. Procedural Used of Traps

2.4.1. Yellow trap

Yellow stickty traps are made of yellow paper (map) and given glue. This trap was installed using wooden stakes which were adjusted to the height of the canopy of the sorghum plant leaves. This trap is made of yellow paper with a size of 30 x 20 cm, installed at the sample point. This trap was installed in the morning at 08.00 am and the collection was carried out on the 3rd day at 06.00 pm, with 8 times setting traps according to the phase of plant growth. The duration of trapping is 3 days on each observation.

2.4.2. Pitfall trap

Pitfall traps are used to catch insects that live above ground level. At each sample point, a plastic water container with a diameter of 9.2 cm and a height of 11.5 cm was planted. Plastic containers filled with aqueous solution given are detergent to make the surface of the plastic container and prevent insects from escaping. The excavated soil is put in a pitfall trap and razed to the ground so that insects are easily trapped when passing through the trap. This trap setting schedule is the same as setting the yellow trap.

2.4.3. Sweep net

The trap is made of translucent gauze are easily swayed so that insects are caught can be seen. Catching insects performed on sample points in the morning and afternoon. These nets are used for the active insect fly. Stem length of approximately 1 meter or adjusted needs, made lighter and stronger metals to be easily swayed. Swings are carried out 20 times or each of 4 swings at 5 points of the sites.

2.4.4. Light trap

The working principle of this light trap is to attract insects that fly toward the light source and then when the swarming insects, they will spin and then into the trap that we post. These traps use emergency lights as a light source. Lamp is placed in the bowl placed on a board that had been nailed to high wooden with appropriate plants, so that insects are attracted fall into the bucket. The installation of this trap is carried out once at 06.00-10.00 pm at each observation according to the sorghum growth phase.

2.4.5. Procedure of identification of insects

Insects are caught there that can be identified directly and there that cannot be identified immediately. Insects found in the field are grouped according to type and preserved in 70% alcohol, then be determined and identified by observing the outer shape (morphology) with the help of loupe, binocular stereo microscope and identification of reference books. Identification was done to the family level.

2.5. Variable Observations

2.5.1. The Number and types of insects trapped

Insects were obtained in the field were collected, identified and quantified according to the insect family group at each observation.

2.5.2. Insect Diversity Index

Calculation of the index value of diversity at each observation using Shannon-Weiner index formula (H). The calculation of data measured of:

a. Absolute Density (AD)

Absolute density indicates the number of insects found in the absolute stated habitat [5].

b. Relative Density (RD)

Relative density is calculated by a formula according to [6] as follows:

$$RD = \frac{AD}{\sum AD} \times 100\% \tag{1}$$

c. Absolute Frequency (AF)

Absolute frequency indicates the total number of insects that are found in the habitat of each observation that is stated absolutely [5].

d. Relative frequency (RF)

The relative frequency shows often present an insect habitat and to describe the spread of the insect species.

$$RF = \frac{AF}{\sum AF} \times 100\% \qquad (2)$$

e. Diversity Index

To compare the high and low diversity of insect species, namely the diversity of insect pests and natural enemies, is used Shanon-Weiner index (H) with the formula:

$$H' = -\sum[(pi) \times \ln(pi)] \qquad (3)$$

Where: H' = Shannon-Weiner diversity index; pi = ratio of the number of individuals of a species with an overall species; Pi = ni / N

With the diversity index criteria according to Krebs (1978) in [7] as follows: H > 3 = High; 1 < H < 3 = Medium; H < 1 = Low

2.5.3. Total intercepted by trap

The number of insects caught in traps trap used to describe relative the ability of good types of traps to catch various types of insects.

2.5.4. Evenness index

The value of evenness indicates the degree of evenness of diversity of individuals between types. Diversity cannot be separated from evenness. To see the evenness of species in a habitat can be calculated using the Pielou formulation:

$$E = H'/S \qquad (4)$$

Where: E = evenness index type; H' = Shannon-Wiener diversity index; S = total overall type

Criteria Evenness Index Type [8]: E < 0.4 = evenness sort of low; 0.4 < E <0.6 = evenness type of medium; E > 0.6 = evenness kinds of higher

That is the total number of species in a community. Species richness in a habitat can be determined by using: −1

2.5.5. Richness index

Formula such as:

$$R = \frac{S}{N} \qquad\qquad (5)$$

where: R = index species richness; S = the total number of species within a habitat; N = the total number of individuals in a habitat

2.5.6. Important Value Index (IVI) and Status of Insects Function

IVI describe the magnitude of the control provided by a species of the community. IVI can be calculated by the formula: IVI = RD + RF Insects are caught and identified divided into insects as herbivores, predators, parasitoids, and other insects.

3. Results and Discussions

3.1. Number and Insects Species Caught

The results obtained showed that the number of insects identified in the sorghum planting area was 10 orders, consisting of 33 families, with a total insect population of 1173 individuals (Table 1).

Observations I is an observation with the lowest number of insect populations because at the initial growth sorghum was aged 20 at the age of Day After Plantation (DAP) where the sorghum is in the growth phase to the 5-leaf stage looks. In this phase is the process of formation and growth of insects and insect populations not get enough food because of the abundance of the sorghum crop is still in the early growth so that it causes a type of insect that is not much. This is in line with research [7] of rice paddy crop diversity index, stating that the first observation of rice insect age of 2 weeks, the number of insects show the lowest number since they process the population growth.

The results showed the number of insects that most caught up in all the traps contained in the observations to IV, VI, V. This is because on these observations sorghum has entered a growth phase reproductive (generative) and is a source of food for insects, in this phase of sorghum has flowered and panicle had bloomed so there are insects which appear to act as pests and pollinators in the growth phase generative sorghum. The high number of individuals who obtained the observations IV, VI, V is also due to the insect has blossomed and grown as time has run and has formed population.

Table 1. Number and Types of Insects are Identified in Sorghum Plantations in Kolam Village, Percut Sei Tuan district, Deli Serdang Regency

Classification		Observation								Total
		Vegetative		Reproductive			Ripening seeds			
The Order	Family	I	II	III	IV	V	VI	VII	VIII	
Coleoptera	Coccinellidae	3	8	14	9	16	22	14	11	97
	Meloidae	0	0	0	3	6	4	3	1	17
	Scarabaeidae	13	17	24	25	18	15	6	6	124
	Mordellidae	0	1	2	1	3	2	0	0	9
	Curculionidae	0	0	2	6	4	3	0	1	16
Diptera	Muscidae	2	4	5	7	3	3	4	2	30
	Syrphidae	0	0	0	1	0	2	4	3	10
	Cucilidae	9	7	12	16	8	11	6	9	78
	Tephrtidae	11	15	9	8	0	0	1	0	44
	Stratiomydae	0	1	0	5	8	6	4	3	27
	Sarchophagidae	1	1	2	4	2	6	6	4	26
Hemiptera	Alydidae	0	0	2	2	6	12	15	9	46
	Pentatomidae	0	1	0	0	3	7	8	10	29
	Gerridae	2	0	4	3	2	5	3	2	21
	Reduviidae	2	2	6	9	5	2	2	0	28
Homoptera	Cicadellidae	3	9	17	9	3	2	0	2	45
Hymenoptera	Sphecidae	0	0	0	4	6	6	9	9	34
	Pompilidae	2	0	3	2	2	1	0	1	11
	Ichneumoidae	0	0	0	2	3	2	0	0	7
	Formicidae	8	7	17	14	32	25	19	15	137
	Tiphiidae	0	0	1	0	2	0	2	0	5
	Vespidae	0	0	0	0	2	1	6	7	16
Lepidoptera	Noctuidae	0	0	2	4	3	1	2	0	12
	Satyridae	1	0	0	1	2	1	1	0	6
	Danaidae	0	0	0	0	0	1	2	2	5
Odonata	Libelluidae	2	3	5	3	3	6	6	7	35
	Coenagrionidae	0	1	0	3	3	1	1	0	9
Orthoptera	Acrididae	8	15	17	14	10	13	7	7	91
	Gryllidae	16	12	8	9	3	4	1	0	53
	Gryllotalphidae	6	6	3	2	2	0	0	0	19
	Blattelidae	0	4	10	13	7	10	4	2	50
Mantodea	Mantidae	0	0	1	2	3	1	4	2	13
Dermaptera	Forficulidae	0	0	5	3	6	4	3	2	23
	Total	89	114	171	184	176	179	143	117	1173

In observation VII and VIII was found that the number of insect populations identified decrease from previous observations, this occurs because of sorghum as a food source of these insects has reached a stage of hardening seeds and physiologically mature, so the food source of some insects are not appropriate as previously, Oka (1995) in [9] states population density is governed by factors such as competition between individuals, chemical changes due to the

secretion and metabolism, lack of food, predators/parasites, emigration. It is also in line with research [7] on rice plants, decrease the insect population at a late stage generative plant growth due to hardening of the tissues of the plant, so the condition is not preferred insect pests.

From the research data, it was found that the highest total population of insects is derived from the family Formicidae. The population of family Formicidae is high in this study site because these insects live in colonies and the presence of available food factors causes the family

Formicidae to rapidly carry out their propagation. [10] states the amount of food available at a suitable quality and sufficient quantity will affect the increase population insects for food is a source of nutrition that is used by insects to live and thrive.

The total population of insects is lowest that is derived from the family Danaidae andfamily Tiphiidae suspected this was due to family Danaidae prefer plants that have flowers, color of flowers, nectar and scent more interesting than sorghum. Accordance to [11] states that that most of butterflies come to flower with bright colors. Meanwhile, suspected to be caused mismatches of family Tiphiidae growth in the sites.

3.2. Calculation Absolute Density (AD), Relative Density (RD), Absolute Frequency (AF), and Relative Frequency (RF)

Absolute density value (AD) is the highest order Hymenoptera, family Formicidae as many as 137 by the value of the Relative Density (RD) of 11.68%. While the absolute density (AD) which is the lowest of the Order Hymenoptera, family Tiphiidae and the Order Lepidoptera, family Danaidae are each as much as 5 to the value of the Relative Density (RD) at 0.43% (described into Table 2). This is in accordance with the [5] which states that the absolute density indicates the number of insects found in habitats which expressed implicitly. Absolute and relative density value is high because the family Formicidae most captured and lower recorded on family Tiphiidae and family Danaidae. Presence of insects depends on the food he got. This is consistent with the statement [12], if food is available with suitable quality and sufficient quantity, the insect population will rise rapidly. Conversely, if the state of the food is less then the insects will also decrease.

Value AF was recorded highest of Coleoptera (Coccinellidae; Scarabaeidae), Diptera (Muscidae; Cucilidae; Sarchophagidae), Hymenoptera (Formicidae), Odonata (Libelluidae) respectively as 8 with the value RF as much as 4.08%. It is assumsed because these insects are often present in the observation area and the spread of the insect widely in the sorghum crop land. This is in accordance with the [5] which states that the relative frequency shows presence an insect species on habitat and to describe the spread of the insect species.

The lowest AF values was recorded from Order of Hymenoptera, the Ichneumoidae family and the Tiphiidae family, the Lepidoptera Order from the Danaidae family as many as 3 individuals

with an RF value of 1.53%. The low value was founded because insects are rarely present in the field of observation and the spread of insects is not widespread on sorghum plantations is assumed because these insects do not have a high population in the research area.

Table 2. The calculation of absolute density, relative density, Absolute and Relative Frequency Frequency at Sorghum planting Village Swimming Subdistrict Percut Sei Tuan, Deli Serdang.

The Order	Family	AD	RD (%)	AF	RF (%)
Coleoptera	Coccinellidae	97	8.27	8	4.08
	Meloidae	17	1.45	5	2.55
	Scarabaeidae	124	10.57	8	4.08
	Mordellidae	9	0.77	5	2.55
	Curculionidae	16	1.36	5	2.55
Diptera	Muscidae	30	2.56	8	4.08
	Syrphidae	10	0.85	4	2.04
	Cucilidae	78	6.65	8	4.08
	Tephrtidae	44	3.75	5	2.55
	Stratiomydae	27	2.30	6	3.06
	Sarchophagidae	26	2.22	8	4.08
Hemiptera	Alydidae	46	3.92	6	3.06
	Pentatomidae	29	2.47	5	2.55
	Gerridae	21	1.79	7	3.57
	Reduviidae	28	2.39	7	3.57
Homoptera	Cicadellidae	45	3.84	7	3.57
Hymenoptera	Sphecidae	34	2.90	5	2.55
	Pompilidae	11	0.94	6	3.06
	Ichneumoidae	7	0.60	3	1.53
	Formicidae	137	11.68	8	4.08
	Tiphiidae	5	0.43	3	1.53
	Vespidae	16	1.36	4	2.04
Lepidoptera	Noctuidae	12	1.02	5	2.55
	Satyridae	6	0.51	5	2.55
	Danaidae	5	0:43	3	1.53
Odonata	Libelluidae	35	2.98	8	4.08
	Coenagrionidae	9	0.77	5	2.55
Orthoptera	Acrididae	91	7.76	8	4.08
	Gryllidae	53	4.52	7	3.57
	Gryllotalphidae	19	1.62	5	2.55
	Blattelidae	50	4.26	7	3.57
Mantodea	Mantidae	13	1.11	6	3.06
Dermaptera	Forficulidae	23	1.96	6	3.06
	Total	1173	100	196	100

*Noted: Absolute Density (AD), Relative Density (RD), Absolute Frequency (AF), Relative Frequency (RF)

3.3. Insect Diversity Index Value

The index value diversity in the field of sorghum crop is H' = 3.115 (Table 3). The species diversity index values indicate that having high insect diversity categories, namely H' more than 3 which stable environmental conditions. This is consistent with the literature diversity index criteria according to Krebs (1978) in [9] as follows: H > 3 = High, 1 < H <3 = Medium, H < 1 = Low.

Table 3. Insect Diversity Index Value of Sorghum Plantations in Kolam Village, Percut Sei Tuan District, Deli Serdang. Noted: pi = ratio of the number of individuals of a species with an overall species; ln = logaritma; H' = Index diversity Shannon Wiener

| The Order	Family	Pi	ln Pi	H'
Coleoptera	Coccinellidae	0.0826	-2493	0205
	Meloidae	0.0144	-4240	0061
	Scarabaeidae	0.1057	-2247	0237
	Mordellidae	0.0076	-4879	0037
	Curculionidae	0.0136	-4297	0058
Diptera	Muscidae	0.0255	-3669	0093
	Syrphidae	0.0085	-4767	0040
	Cucilidae	0.0664	-2712	0180
	Tephrtidae	0.0375	-3283	0123
	Stratiomydae	0.0230	-3772	0086
	Sarchophagidae	0.0221	-3812	0084
Hemiptera	Alydidae	0.0392	-3239	0126
	Pentatomidae	0.0247	-3700	0091
	Gerridae	0.0179	-4022	0071
	Reduviidae	0.0238	-3738	0088
Homoptera	Cicadellidae	0.0383	-3262	0124
Hymenoptera	Sphecidae	0.0289	-3543	0102
	Pompilidae	0.0093	-4677	0043
	Ichneumoidae	0.0059	-5132	0030
	Formicidae	0.1167	-2128	0258
	Tiphiidae	0.0042	-5472	0022
	Vespidae	0.0136	-4297	0058
Lepidoptera	Noctuidae	0.0102	-4585	0046
	Satyridae	0.0051	-5278	0026
	Danaidae	0.0042	-5472	0022
Odonata	Libelluidae	0.0298	-3513	0104
	Coenagrionidae	0.0076	-4879	0037
Orthoptera	Acrididae	0.0775	-2557	0198
	Gryllidae	0.0451	-3098	0139
	Gryllotalphidae	0.0161	-4128	0066
	Blattelidae	0.0426	-3155	0134
Mantodea	Mantidae	0.0110	-4509	0049
Dermaptera	Forficulidae	0.0196	-3932	0077

Insect diversity index in this study area is assumed to be high because of the way the cultivation of plants carried out in sorghum plantations is carried out without the provision of chemical pesticides or chemical fertilizers on these crops, where with given chemical pesticides is made of natural populations of insects remain in balance and does not result in increased certain insect populations. This is in accordance literature [13] suggest that negative impacts can result from pesticide that is the demise of natural enemies or predators, resulting in pest resistance. This is also consistent with the statement of [14] states that excessive pesticide can induced pest resistance and the onset of the second, and reduced natural enemies and death of other insects.

Based on the data it can be seen that the index of diversity on the location of the sorghum plantations area is high. This happens because the plantations and sorghum are in the condition of heterogeneous and there are other plants rounded and there is vegetation weed this case in accordance with the statement of [9] suggested heterogeneity in space, the more heterogeneous a physical environment increasingly complex community of flora and fauna in one place scattered and higher the diversity of species.

3.4. The Number of Insects Caught by Traps

The number of insects caught by four traps, such as; yellow sticky trap. Used of sweep net, pitfall trap and light trap described into Figure 1. The results showed that the number of insects trapped by the trap is as follows yellow trap 470 individuals, sweep net 313 individuals, 189 individuals pitfall trap, light trap were 201 individuals. The results of research with the most trapping insects are yellow traps, this is also supported by the research results of [15] states that the effectiveness of the use of yellow stick trap can catch various types of insects in the planting area because of the attraction of insects to the color yellow and is able to trap insects around the surface of the plant. More [16] and [17] states that the insect traps very good yellow color is used in monitoring and evaluating the types and the insect population in the area of agricultural crops because it has a good ability to be able to catch various types of insects, especially pest insects even natural enemies are all around planting. The elements of climate that are very influential on pests, including are temperature, humidity, moisture content of materials, light and aeration [8]. The environmental were measured, such as similar temperature (32°C -35°C), pH (6-7.5), humidity assumes (70%-80%), and rainfall (200 mm/month) assumed all the environmental factors did not effected directly to growth of insects in sorghum sites.

The results of the lowest insect trap used by pitfall trap, assumed the trap has ability to trap insects that active on surface of the ground, while the existing soil insects in crops were relatively fewer recorded. According to [18] and [19] that an effective insect species caught and inventory at ground level, consist of Order Hymenoptera (family Formicidae, family Grylotalpidae), while order Orthoptera (family Staphylinida) and order Coleoptera as family Curculionoidae.
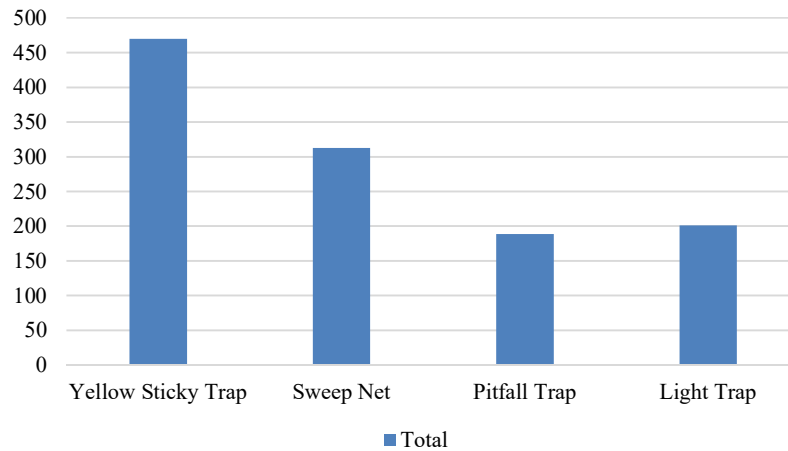
Figure 1. The Number of Insects Caught by Traps in Sorghum Plantations

3.5. Evenness Index Value Type

Evenness data shows the level of distribution of individual types of species that exist in the community. Evenness index value in sorghum plantations = 0.891 (Table 4), this value shows the distribution of individuals evenly because it approaches the value 1. The greater the value, the more balanced the distribution pattern of a species in the community, this means that in the sorghum plantations studied there is not a very dominating insect population because almost the same abundance. This is consistent with [8] statement that equality is the distribution of all individuals in a community.

Table 4. Evenness Index Value Type (E)

No.	H '	Σ type (S)	Evenness Index (E)
1.	3115	33	0891

Evenness index value E insects in crops of sorghum categorized as high, meaning that the number of individuals and any type of the sorghum crop area evenly so that every individual has equal opportunity in the community to be able to run the ecological function either as pests, parasitoids and predators. This is consistent with the statement [8] that the evenness index criteria: E < 0.4 = Evenness kind of low, 0.4 < E < 0.6 = Evenness type of medium, E > 0.6 = Evenness categorized into of higher score.

3.6. Richness Index

The results of the analysis of the Richness index value (R) in crops of sorghum categorized as high (R > 4) is R = 4.15 described into Table 5.

Table 5. Richness Index Value (R)

No.	Σ type	Σ Individuals	Margalef Index
1.	33	1173	4:15

This is in accordance with literature [20] which states that the Richness index can be calculated using a formula adopted from Margalef (1958) with the following criteria: R < 2.5 indicates a low level of species richness 2.5 > R > 4 shows the level of species richness were R > 4 shows a high level of species richness.

3.7. Important Value Index and Status Functions of Insects

The Important Value Index (IVI) and status of insects were described into Table 6. Based on Table 6, the insect that has the highest potential to be a pests with categorized into Family Scarabaeidae (IVI=14.65%), an important value index illustrates the important role of a species in an ecosystem. According to [21], this insect is a pest that eats plant material. And these results are also in accordance with [21], stating a species with the highest IVI tends to dominate habitat because the environment is suitable as a place. In addition insects with the highest of IVI are described which abundant insects and active number of species in crops.

Predatory insects with the highest IVI categorized into family Formicidae with IVI = 15.76%. IVI height is influenced by several factors, such as: survival, adaptation of high habitat, and the ability utilize existing resources. According [21], the insect is a predator such as Coccinellidae, Sphecidae, Pompilidae, Coenagrionidae, and Libelluilidae. The results of this study are also in accordance with the literature [22] which states that a high IVI was influenced by the ability of an organism to reproduce and adapt to environmental conditions.

Based on the status of the function of insects in crops of sorghum categorized insects herbivore consist of 12 families, insect parasitoids are 3 families, 11 species of predatory insects families and 4 families pollinator categories and 3 families of decomposers. This is consistent with the statement of [9] which states that the agricultural ecosystem each species of insects exhibit properties typical population. Besides, all types of insects in agro-ecosystems cannot categorized into pests, but are natural enemies of pests, such as predators, parasitoids, and insect pollinator. The accordance of [14] states that the more diverse the community with varied of insects in the population will interact with each other to form food web stable.

Table 6. Important Value Index and Status Functions of Insects

The Order	Family	Status function	% IVI
Coleoptera	Coccinellidae	Predator	12.35
	Meloidae	Herbivore	4
	Scarabaeidae	Herbivore	14.65
	Mordellidae	Herbivore	3.32
	Curculionidae	Herbivore	3.91
Diptera	Muscidae	Decomposers	6.64
	Syrphidae	Predator	2.89
	Cucilidae	Pollinators	10.73
	Tephrtidae	Herbivore	6.3
	Stratiomydae	Parasitoids	5.36
	Sarchophagidae	Decomposers	6.3
Hemiptera	Alydidae	Herbivore	6.98
	Pentatomidae	Herbivore	5.02
	Gerridae	Predator	5.36
	Reduviidae	Predator	5.96
Homoptera	Cicadellidae	Herbivore	7.41
Hymenoptera	Sphecidae	Predator	5.45
	Pompilidae	Predator	4
	Ichneumoidae	Parasitoids	2.13
	Formicidae	Predator	15.76
	Tiphiidae	Parasitoids	1.96
	Vespidae	Pollinators	3.4
Lepidoptera	Noctuidae	Herbivore	3.57
	Satyridae	Pollinators	3.06
	Danaidae	Pollinators	1.96
Odonata	Libelluidae	Predator	7.06
	Coenagrionidae	Predator	3.32
Orthoptera	Acrididae	Herbivore	11.84
	Gryllidae	Herbivore	8.09
	Gryllotalphidae	Herbivore	4.17
	Blattelidae	Decomposers	7.83
Mantodea	Mantidae	Predator	4.17
Dermaptera	Forficulidae	Predator	5.02

4. Conclusion and Recommendation

The Richness index value (R) with score was the higher (R = 4.1). The value of evenness index was 0.891 (higher). The dominant insects recorded from Order of Hymenoptera (Family of Formicidae), continued to order Coleoptera (Family of Scarabaeidae; Family Coccinellidae) are quite diverse in the sorghum plantations. The most potential insect as a pest with the highest IVI categorized into family Scarabaeidae (IVI = 14.65%), while the highest IVI predator insect was

IVI = 15.76% (family Formicidae). The diversity index calculated was higher (H' = 3.115), which indicated into stable environmental conditions.

REFERENCES

[1] N. Siregar and T. Irmansyah, "Pertumbuhan dan Produksi Sorgum Manis (Sorghum bicolor (L.) Moench) Terhadap Pemberian Mulsa dan Bahan Organik: The Growth and Yield of Sweet Sorghum (Sorghum bicolor (L.) Moench) On The Mulch Treatments and Organic Matter," *J. Online Agroekoteknologi*, vol. 4, no. 3, pp. 2188–2195, 2016.

[2] M. P. Sirappa, "Prospek pengembangan sorgum di Indonesia sebagai komoditas alternatif untuk pangan, pakan, dan industri," *J. Litbang Pertan.*, vol. 22, no. 4, pp. 133–140, 2003.

[3] F. X. Wagiman, *Hama Pascapanen dan Pengelolaannya*. UGM PRESS, 2019.

[4] P. W. Price, *Insect ecology*. John Wiley & Sons, 1997.

[5] G. L. Purba, M. Marheini, and S. Oemry, "Interaksi trofik jenis serangga di atas permukaan tanah dan permukaan tanah beberapa pertanaman varietas jagung (Zea mays Linn.)," *J. Agroekoteknologi Univ. Sumatera Utara*, vol. 3, no. 3, p. 104901, 2015.

[6] A. Saragih, "Indeks Keragaman Jenis Serangga Pada Tanaman Stroberi (Fragaria Sp) Di Lapangan," Universitas Sumatera Utara, 2008.

[7] M. S. Sianipar, L. Djaya, E. Santosa, R. C. H. Soesilohadi, W. D. Natawigena, and M. P. Bangun, "Indeks Keragaman Serangga Hama Pada Tanaman Padi (Oryza sativa L.) Di Lahan Persawahan Padi Dataran Tinggi Desa Sukawening, Kecamatan Ciwidey, Kabupaten Bandung," *Bioma Berk. Ilm. Biol.*, vol. 17, no. 1, pp. 9–15, 2015.

[8] K. J. Cho, "Ryoo, and SY Kim. 1988. Life table statistic of rice weevil (Coleoptera: Curculionodae) in relation to the presence of rough, brown and polished rice," *Korean. Entomol*, vol. 18, pp. 1–16.

[9] D. T. Tambunan, D. Bakti, and F. Zahara, "Keanekaragaman Arthropoda Pada Tanaman Jagung Transgenik," *J. Agroekoteknologi Univ. Sumatera Utara*, vol. 1, no. 3, p. 95369, 2013.

[10] V. Sidabutar and L. Lubis, "Indeks Keanekaragaman Jenis Serangga pada Fase Vegetatif dan Generatif Tanaman Kedelai (Glycine maxMerill) di Lapangan: Diversity of insects on vegetative and generative phase of soybean (Glycine maxMerill) in the field," *J. Online Agroekoteknologi*, vol. 5, no. 2, pp. 474–483, 2017.

[11] H. Davies and C. A. Butler, *Do butterflies bite?: Fascinating answers to questions about butterflies and moths*. Rutgers University Press, 2008.

[12] R. I. Depkes, "Entomologi Serangga." Direktorat Jenderal P2M dan PLP, 1999.

[13] K. Untung, "Pengantar Pengelolaan Hama Terpadu Ed-2." Yogyakarta: Gadjah Mada University Press, 2006.

[14] O. I. Nyoman, "Pengendalian Hama Terpadu dan Implementasinya di Indonesia." Gadjah Mada University Press. Yogyakarta, 1995.

[15] A. Mas'ud, "Efektifitas Trap Warna Terhadap Keberadaan Serangga Pada Pertanaman Budidaya Cabai di Kelurahan Sulamadaha Kecamatan P. Ternate," *J. Chem. Inf. Model.*, vol. 53, p. 159, 2002.

[16] K. M. Heinz, M. P. Parrella, and J. P. Newman, "Time-efficient use of yellow sticky traps in monitoring insect populations," *J. Econ. Entomol.*, vol. 85, no. 6, pp. 2263–2269, 1992.

[17] Naryanta, "Efektifitas Penangkapan Sticky Trap dengan Variasi Bentuk dan Warna pada Lalat Penggorok Daun Bawang Putih, Liriomyza sp. (Diptera : Agromyzydae).," UNS Surakarta, 1991.

[18] N. Hariyano, "Inventarisasi Serangga dengan Pit Fall Trap di Kawasan Perkebunan

(Ground Insect Inventarisation). http." 2015.

[19] G. R. Tambunan, M. U. Tarigan, and L. Lisnawita, "Indeks Keanekaragaman Jenis Serangga pada Pertanaman Kelapa Sawit (Elaeis guineensis Jacq.) di Kebun Helvetia PT. Perkebunan Nusantara II," *J. Agroekoteknologi Univ. Sumatera Utara*, vol. 1, no. 4, p. 95735, 2013.

[20] A. Ismawan, S. E. Rahayu, and A. Dharmawan, "Kelimpahan dan Keanekaragaman Burung di Prevab Taman Nasional Kutai Kalimantan Timur," *J. online UM*, vol. 3, no. 1, pp. 18–25, 2015.

[21] D. J. Borror, C. A. Triplehorn, and N. J. Johnson, *Pengenalan pelajaran serangga*. Gadjah Mada University, 1992.

[22] R. C. Aditama and N. Kurniawan, "Struktur Komunitas Serangga Nokturnal Areal Pertanian Padi Organik pada Musim Penghujan di Kecamatan Lawang, Kabupaten Malang.," *Biotropika J. Trop. Biol.*, vol. 1, no. 4, pp. 186–190, 2013.