The Diversity of Phytophage and Entomophage Insect Species in Sugarcane Plantations Planted with Flowering Plants

Saida Fitriani Azim¹, Chandra Irsan² and Yulia Pujiastuti

¹ Master Program in Agriculture Sciences, Faculty of Agriculture, Sriwijaya University, Indonesia
² Jl. Padang Selasa No. 524 Bukit Besar Palembang 30139 South Sumatera, Indonesia

*Corresponding author
E-mail address: scaidafitriani@yahoo.co.id (Saida Fitriani Azim).
Peer review under responsibility of Biology Department Sriwijaya University

Abstract:
This study aimed to know the influence of planting the flowering plants in sugarcane plantation on the index value of diversity, domination, and the eveness of phytophage and entomophage insect species in sugarcane plantation. This study was done on two-month and six-month sugarcane of PT. Perkebunan Nusantara VII Cinta Manis District. The research location is located in Ketiau Village, Lubuk Keliat District, Ogan Ilir Regency, South Sumatra. The study was conducted from July to December 2018. Insects that came to flowering plants were collected by using fitfall traps, nets, and direct capture of insects that came. The results showed that the age of sugarcane affected the diversity of Entomophage and Phytophage insect species that came to the flowering plants. At 2-moth-old sugarcane plantations were found 42 species (388 individuals) and 6-month-old sugarcane plantations were found 41 species (284 individuals). The diversity of Phytophage and Entomophage species that came to flowering plants in the 2-month-old sugarcane plantations was almost the same as in the 6-month-old sugarcane plantations. Phytophage species diversity index values were 2.826 and 2.548, while Entomophage were 2.564 and 2.867.

Keywords: Flowering plants; sugarcane plantations; phytophage; entomophage

Received: December 19, 2019, Accepted: April 22, 2020

1. Introduction

Plantation crops are very important in the base of agricultural natural resources. Plantation sub-sectors is the one of that has an important contribution in terms of value creation reflected in its contribution to gross domestic product of Rp. 159.75.9 billion in 2013[1].

South Sumatra is one of the provinces contributing the largest production of dry land plantation commodities, one of which is sugarcane commodity. The area of sugarcane in Cinta Manis dry land is approximately 25 thousands hectares [2]. Sugarcane (Saccharum officinarum) is the most important raw material in making sugar. The composition of the sap consists of about 75-80% water and about 20-25% dry matter [3], in this dry material sucrose content, sucrose accumulation in young stems is the lowest [4].

Pest insects control using flowering plants has not received much attention from farmers and companies engaged in agricultural production. Control with this method in sugarcane planting is expected to suppress attacks from stem and bud borer pests biologically. Biological control has advantages compared to other methods of control, because it does not have negative influence on agricultural products produced [5].

This biological control still tends to the use of entomophage insects to control agricultural insect pests. The use of parasitoid and predators insects has been widely practiced besides using biological agents. To control sugarcane borer pests, it has been been used Trichogramma spp parasitoid [6]. Failure in controlling can occur if the parasitoids and predators lack of food source (nectar or honey) for insects. Flowering plants can improve predator visited and pollen supply and nectar and breeding sites and increasing fecundity predator [7]. The nectar and pollen content in flowers is also become attraction for insects. Marigold flower as rich source of nectar and polen for honeybee species [8]. Planting flowering plants with attractive colors around or at the edge of agricultural or plantations can increase the biological control of agricultural pests.
However, surprisingly there are few publications published where the addition of flowering plants has both increased natural enemy populations and increased pest suppression [9]. There are many types of flowering plants both single flowers and plural flowers and some even provide a source of food that is small or large. Flowers must be chosen carefully to provide resources that are easily accessed by natural enemies but not by moths or other pests that use pollen [10] or by predators or parasitoids from natural enemy species that are being sought for conservation [11].

Insects associated with sugarcane plantations have diverse expertise. These insects can act as phytophages, predators, pollinators [12]. Insects really like flowers, they visit flowers to get food sources, namely pollen and nectar. Because flowers attract large numbers of useful arthropods, that blooming marigold flower is attracted by three species of honeybee viz. *A. Cerana*, *A. Florea* and *A. Dorsata bides* four species from anthophoridae and one each from vespidae and scolidae. [13], [13].

2. Materials and Methods

2.1. Place and Time

This study was conducted in a sugarcane plantation of PT. Perkebunan Nusantara VII Cinta Manis District Sugarcane Estate. The study location is located in Ketiua Village, Lubuk Keliat District, Ogan Ilir Regency, South Sumatra. The study in this location was done in July to December 2018. The research plots were located near sugarcane plantations aged 2 and 6 months.

2.2. Materials and Tools

The tools used in this study include stationery, jars, macro cameras (Nikon), microscopes, vial bottles, jars, tweezers, insect nets, insect traps, meters, insect identification key books and Past Software 2.1. The ingredients used are yellow cosmos flowers, marigolds flower seeds, bougenvillea flower seeds, and 70% alcohol.

2.3. Research Methodology

This research was conducted by using the experimental method. Experiment was carried out in sugarcane fields aged 2 and 6 months. There were 3 plant treatments carried out, first planting single type of flower, second planting 2 types of flowers, and third planting 3 types of flowers.

\[ T_1 = A_1 B_1 C_1 \]
\[ M_{x2} = AB_2 AB_2 AB_2 \]
\[ M_{x3} = ABC \]

Note: (A) Yellow Cosmos flowers (*Cosmos sulphurus*), (B) Bougenvillea (*Zinnia elegans* Jacq), and (C) marrigold (*Tagetes electro*).

2.4. Procedure

a. Determine Research Location

The area of sugar cane plantations owned by PT. Perkebunan Nusantara VII Cinta Manis District Sugarcane Estate South Sumatra reaches 2,733.0 hectares. The study was conducted on sugar cane plantations aged 2 and 6 months. Sugarcane planting plots with these criteria are located in Rayon IV plot. Location of flower seed planting was done on area of 100 m² (20 m x 5 m) see (Figure 3.1).

![Figure 3.1. Map of 2-month-old and 6-year-moth-old Sugarcane Planting Areas Planted with Flowering Plants](image)

b. Making the Trap Equipment

Ground Insect Trap (Fit Fall Trap)

The trap was made of plastic cup with 12 ml volume (6.5 cm Top diameter, 9.5 cm height). On the cup was perforated at the height of 1 cm from the base to prevent rain water from entering.

Insect Nets

Insect nets were made of white gauze formed in cone with 60 cm height. Stick the gauze on 30 cm diameter steal and sew it with wire and after that attach it on 1 meter length net stick.

2.5. Planting the Flowering Plants

Cultivation of land using plow along the sugarcane plantations aged 2 and 6 months at an area of 100 m² (20 m x 5 m) with a spacing of 10 meters. Yellow cosmos seeds, bougenvillea, and marigolds are sown in the land along the sugarcane plantations that had been prepared. Watering was done every morning and evening on the land that had been sown with flower seeds.

2.6. The Installation of Pitfall Trap

a. Pitfall Trap

Pitfall trap had been used to catch the active insect on the surface of the ground. Dig a hole of 6.5 cm to be installed with pitfall traps in 3 points; the first was flower planting area, the second was sugar cane planting area, and
the third was between flowering plant and sugarcane planting area. Into the pitfall trap installed, it was inserted detergent liquid as high as 2cm. Examination of trapped insects by the pitfall trap was left in place 24 hours after being installed.

b. Insects Nets

Insect nets were used to catch insects in flowering plants and around sugar cane plants. The use of insect nets was done at 07.00 – 10.00 a.m. The insect net was swung on the surface of the flower plant by counting the 10 swing swings (5 left and 5 right). Insects caught in the net are put into plastic bags and tied with rubber and then labeled the date, day and place of the insects that were caught and then taken to the laboratory to be identified.

c. Visual Observation

The active insects that on the flowering plants were also documented. On the camera were set date, day, and place to take insect photos. Insects found on the flowers were identified. Observation of pitfall traps, nets, visually was done every 1 week.

2.7. Insect Sample Identification

Samples that had been obtained were then identified. Identification was done at the Natural Enemy Laboratory of Cinta Manis Sugarcane Estate of PT. Perkebunan Nusantara VII by using identification books written [14],[15],[16],[17],[18]. Identification was conducted macroscopically and microscopically using a stereo microscope. The observed insects were made documentation in the form of photographs. Identification was done based on morphological characteristics to determine the Order, Family and Genus of Species.

2.8. Data Analyses

Number of species or number of individuals between sugarcane plantations aged 2-month-old and 6-month-old was done using the analyses Chi-square goodness of fit test. Whereas for the analysis of insect species structure was calculated using (INP) Important Value Index, namely diversity using the Shannon index, dominance, evenness calculated with equations A.1, A.2, and A.3.

a. The Diversity Index

The result of sampling data in the field was done to count species as in the Shanon-Wiener calculation [19]:

\[ H = - \sum p_i \ln p_i \]

..... A.1

Note:
\[ H = \text{Diversity Index Shannon-Weiner} \]
\[ S = \text{Number of Species} \]
\[ p_i = \frac{n_i}{N} \]
\[ n_i = \text{Number of species individual at} \ldots \]
\[ N = \text{The sum number of species} \]

b. Dominance Index

Dominance Index, according to [17], can be counted by using the following formula:

\[ e = \frac{H'}{H_{\text{max}}} \]

.....A.2

Note:
\[ E = \text{Uniformity Index} \]
\[ H_{\text{max}} = \text{Maximum Diversity (ln S)} \]
\[ S = \text{Species Number} \]

Evenness Index values have criteria:
\[ e < 0.5 \]

= Evenness among species is low, because the individual wealth possessed by each species is very different.

\[ e > 0.5 \]

= The relationship between species is relatively even or the number of individuals of each species is relatively equal.

C. Evenness Index

According to [20] species dominance at each station that can be different, then it can be determined by Simpson's dominance index as follows:

\[ D = \sum \left( \frac{n_i}{N} \right)^2 \]

.....A.3

Note:
\[ D = \text{Simpson Dominance Index} \]
\[ n_i = \text{The number of individual species} \]
\[ N = \text{Number of individual} \]

The criteria of dominance is as follows:
\[ D < 0.5 \]

= There are no species that dominate other species or community structures in a stable condition

\[ D > 0.5 \]

= There are species that dominate other species or unstable community structures, due to ecological stress.

3. Results and Discussion

The result showed that the age of sugarcane can effect the diversity of entomophage and phytophage insects in flowering plants planted near sugarcane plantations aged 2 and 6 months. Phytophage and entomophage insects found on flowering plantations planted on sugarcane plantations aged 2 months were more than sugarcane plantations aged 6 months.
The results showed that the yellow color of flowers could affect the presence of entomophage and phytophage insects. In the Yellow Cosmos (Cosmos Sulphereus) more insects were found than on the paper flower (Zinnia elegans) and marigold (Tagetes Electra) plants. In Figure 2, it can be seen that (a) yellow cosmos flower is the dominant type of yellow flower, (b) bougainvillea flower has various flower color variants, and (c) marigold flower has a scent that can be a repellent or attractor for insects.

**3.1 The influence of 2-month-old and 6-month-old sugarcane plants on the diversity of entomophage and phytophage insect species surrounding flowering plants**

The results showed that insect species found in flowering plantations that were planted near the 2-month-old sugarcane plantations were 42 species and in the 6-month-old sugarcane plantations there were 41 species.

The number of phytophage insects in flowering plantations planted near the 2-month-old sugarcane plantations was 388 and in the 6-month-old sugarcane plantations there were 284. (Table 4.1)

| Ordo/Family     | Species                                      | 2 months | 6 months | Σ   |
|-----------------|----------------------------------------------|----------|----------|-----|
| **Coleoptera**  |                                              |          |          |     |
| Carabidae       | Agonum sp                                    | 13       | 0        | 13  |
|                 | Amara sp                                      | 4        | 4        | 8   |
| Chrysomelidae   | Altica aenescens                             | 20       | 6        | 26  |
|                 | Aulacophora frontalis                        | 0        | 3        | 3   |
|                 | Cassida vibex                                 | 0        | 14       | 14  |
|                 | Adoxia benallae                               | 11       | 0        | 11  |
|                 | Callidex munhypomalceum                      | 13       | 0        | 13  |
|                 | Hispellinus multi spinosus                    | 3        | 0        | 3   |
| Cerambycidae    | Hesthesis sp.                                 | 4        | 0        | 4   |
| Coccinellidae   | Coccinella transversals*                      | 16       | 14       | 30  |
|                 | Coccinella septempunctata*                    | 0        | 2        | 2   |
|                 | Pseudocymbus sylvaticus*                      | 6        | 9        | 15  |
|                 | Harmonia quadripunctata                      | 2        | 0        | 2   |
|                 | Cryptolaemus montrouzieri*                    | 16       | 0        | 16  |
|                 | Epilachna sambana                            | 4        | 0        | 4   |
| Curculionidae   | Symnus sp.                                   | 8        | 0        | 8   |
| Dytiscidae      | Meriphus sp.                                 | 3        | 0        | 3   |
|                 | Hypera sp.                                   | 27       | 17       | 44  |
| Elateridae      | Rhantus suturalis                            | 4        | 0        | 4   |
| Nitidulidae     | Ampedus balteatus                            | 3        | 0        | 3   |
|                 | Aethina sp.                                  | 4        | 0        | 4   |
| Insect Order            | Family                | Species                      | Male | Female | Total |
|-------------------------|-----------------------|------------------------------|------|--------|-------|
| **Oedemeridae**         |                       | *Nacerdes melanura*          | 5    | 0      | 5     |
| **Scarabaeidae**        |                       | *Cyclocephala sp.*          | 10   | 0      | 10    |
| **Staphylinidae**       |                       | *Carpelinus*                | 5    | 0      | 5     |
| **Philonthus**          |                       |                              | 0    | 7      | 7     |
| **Collembola**          |                       | *Entomobrya*                | 4    | 1      | 5     |
| **Diptera**             |                       | *Challiphora*               | 3    | 4      | 7     |
| **Challiphoridae**      |                       |                              | 0    | 9      | 9     |
| **Dholichophoridae**    |                       | *Chrysoma leucopogon*       | 20   | 4      | 24    |
| **Sarcophagidae**       |                       | *Sarcophaga carnaria*       | 9    | 4      | 13    |
| **Syrrhidae**           |                       | *Eristalis tenax*           | 0    | 5      | 5     |
| **Muscidae**            |                       | *Musca*                     | 2    | 0      | 2     |
| **Hemiptera**           |                       | *Leptocorisa acuta*         | 5    | 1      | 6     |
| **Coreidae**            |                       | *Nezara viridula*           | 0    | 8      | 8     |
| **Hymenoptera**         |                       | *Apis melifera*             | 5    | 18     | 23    |
| **Appidae**             |                       | *Amogilla quadriaculata*    | 0    | 7      | 7     |
| **Braconidae**          |                       | *Stenobracon riceivillei*   | 1    | 0      | 1     |
| **Elasmidae**           |                       | *Elasmus nautantidis*       | 0    | 5      | 5     |
| **Formicidae**          |                       | *Anoplolepis gracilipes*    | 0    | 11     | 11    |
| **Componotus lateralis**|                       |                              | 15   | 0      | 15    |
| **Comptonotus sachalinensis** |              |                              | 13   | 0      | 13    |
| **Forelius pruinus**    |                       |                              | 41   | 0      | 41    |
| **Oecophylla smaragdina** |                     |                              | 23   | 12     | 35    |
| **Paratrechina longicornis** |                 |                              | 0    | 20     | 20    |
| **Pheidole* sp.**       |                       |                              | 0    | 5      | 5     |
| **Ichneumonidae**       |                       | *Diagdema*                  | 1    | 0      | 1     |
| **Scelionidae**         |                       | *Telenomus dignoides*       | 8    | 0      | 8     |
| **Vespidae**            |                       | *Ancistroces trifasciatus*  | 0    | 7      | 7     |
| **Parancistrocerus declivatus** |              |                              | 7    | 0      | 7     |
| **Lepidoptera**         |                       | *Syntomoisys syn amata*     | 0    | 9      | 9     |
| **Erebidae**            |                       | *Thymelicus lineola*        | 0    | 5      | 5     |
| **Hesperiidae**         |                       | *Mycasis peresus caesonia*  | 0    | 6      | 6     |
| **Nymphalidae**         |                       | *Appias libythea*           | 0    | 7      | 7     |
| **Pieridae**            |                       | *Appias olferna*            | 10   | 2      | 12    |
| **Pterophoridae**       |                       | *Emmelia monodactyla*       | 0    | 3      | 3     |
| **Mantodea**            |                       | *Hierodula hanscaucasica*   | 5    | 9      | 14    |
| **Mantidae**            |                       | *Sphodromantis viridis*     | 0    | 8      | 8     |
| **Hymenopodidae**       |                       | *Creobrotor sp.*           | 8    | 4      | 12    |
| **Odonata**             |                       | *Odontomantis sp.*          | 0    | 1      | 1     |
| **Libellulidae**        |                       | *Neorothemis ramburii*      | 0    | 1      | 1     |
| **Orthetrum trinarria*  |                       |                              | 0    | 1      | 1     |
| **Orthoptera**          |                       | *Acrida sp.*                | 14   | 9      | 23    |
| **Acrididae**           |                       | *Caelfera*                  | 0    | 2      | 2     |
| **Chorthippus caliginosus** |                 |                              | 9    | 5      | 14    |
| **Melanoplus flavidus** |                       |                              | 4    | 0      | 4     |
| **Paracorina tricolor** |                       |                              | 0    | 9      | 9     |
| **Phaneroptera nana**   |                       |                              | 0    | 9      | 9     |
| **Gryllidae**           |                       | *Gryllus asimilis*          | 0    | 1      | 1     |

| Sum of Spesies | 42 | 41 | 68 |
|----------------|----|----|----|
| Sum of Individuals | 388 | 284 | 672 |
| Khi Kuadrat sum of spesies $p$ | 0(0.0001) |
| Khi Kuadrat sum of individuals $p$ | 16.095** (<0.0001) |

Note: Entomophage *

**Significance ($p$) < 0.05
In Table 4.1 it can be seen that there were entomophage insect species found in flowering plants that are planted near sugarcane plantations at 6 months and 2 months. There were entomofag insect species which were only found in flowering plants planted near the 6-month-old sugarcane plantations. There were phytophage species that only found in flowering plants planted near 2-month-old sugarcane plantations but were not found in 6-month-old sugarcane plantations or vice versa. It showed that the age of sugarcane plants can affect the presence of phytophage insects that come to flowering plants.

### 3.2 The Diversity Insect Species found on flowering plants yellow cosmos flower, marigold flower, and paper flower planted near 2-month-old sugarcane plantations.

The results showed that the number of insect species in the flowering plants yellow cosmos flower planted near the 2-month-old sugarcane crops were 30 species. Insects species that were found in flowering plants marigold were 13 species, and on flowering plants paper flower were 18 species. The number of insect individuals in the flowering plants yellow cosmos flower was more than flowering plants marigold and paper flower. (Table 4.2).

| Ordo / Family | Species | Insect found on flowering plants |
|--------------|---------|---------------------------------|
|              |         | Cosmos sulphureus | Tagetes erecta | Zinnia elegans |
| **Coleoptera** |         |                   |               |               |
| Carabidae    | Agonum sp. | 0              | 0            | 3              |
|              | Amara sp.  | 1              | 0            | 0              |
| Cerambycidae | Hesthesis sp | 1           | 0            | 0              |
| Chrysomelidae| Adoxia benallae | 0         | 0            | 0              |
|              | Altica aenesens | 6       | 1            | 3              |
|              | Callidemumhypochalceum | 2     | 0            | 0              |
|              | Hispellinusmultispinosus | 2    | 0            | 0              |
| Coccinellidae| Coccinella transversals | 6     | 2            | 3              |
|              | Cryptolaemus montroazieri | 3    | 0            | 1              |
|              | Epilachna sumbana | 3    | 0            | 1              |
|              | Harmonia quadripunctata | 0   | 0            | 2              |
|              | Pseudosycmnus syyaticus | 1    | 0            | 0              |
|              | Sycmnus sp.  | 2          | 0            | 1              |
| Cucurulionidae| Hypera sp. | 5            | 3            | 4              |
|              | Meriphus sp. | 1          | 0            | 0              |
| Dytiscidae   | Rnantus suturalis | 0        | 1            | 0              |
| Elateridae   | Ampedus balteatus | 1      | 0            | 0              |
| Nitidulidae  | Aethina sp. | 1            | 0            | 0              |
| Oedemeridae  | Nacerdes melanura | 1      | 0            | 0              |
| Staphylinidae| Carpelinus | 0            | 2            | 1              |
| **Diptera**  | Challiphorida | 0       | 0            | 1              |
|              | Dholichophorida | 5    | 0            | 0              |
|              | Sarcophagidae | 2      | 0            | 1              |
|              | Muscidae | 0            | 1            | 0              |
In Table 4.2 it can be seen that there were ordo coleoptera species *Coccinella transversals* and *Altica aenescens* which were mostly found in flowering plants yellow cosmos flower. Otherwise, there were insect species that were only found in flowering plants paper flower and marrigold but not found in the flowering plants yellow cosmos flower.

3.3 The Diversity Insect Species found on flowering plants yellow cosmos flower, marrigold flower, and paper flower planted near 6-month-old sugarcane plantations.

The results showed that the number of insect species in the flowering plants yellow cosmos flower was more than flowering plants paper flower and marrigold. Insects species that were found in flowering plants yellow cosmos flower were 32 species, and on flowering plants paper flower were 20 species. Insects species that were found in flowering plants marrigold were 18 species. (Table 4.3).

### Table 4.3. Insect Species found on flowering plants yellow cosmos flower, marrigold flower, and paper flower planted near 6-month-old sugarcane plantations at PTPN VII Cinta Manis.

| Ordo / Family | Species | *Cosmos sulphureus* | *Tagetes erecta* | *Zinnia elegans* |
|---------------|---------|---------------------|-----------------|-----------------|
| **Coleoptera**|         |                     |                 |                 |
| Chrysmolidae  | *Altica aenescens* | 1                   | 0               | 1               |
|               | *Aulacophora frontalis* | 1                     | 0               | 0               |
|               | *Cassida vibex* | 3                   | 2               | 1               |
| Coccinelidae  | *Coccinella transversals* | 4                   | 1               | 2               |
|               | *Coccinella septempunctata* | 0               | 0               | 0               |
|               | *Sycmus rebrumaculatus* | 2                   | 1               | 1               |
| Curculionidae | *Hypera sp.* | 3                   | 2               | 2               |
|               | *Philonthus* | 1                   | 0               | 0               |

In Table 4.2 it can be seen that there were ordo coleoptera species *Coccinella transversals* and *Altica aenescens* which were mostly found in flowering plants yellow cosmos flower. Otherwise, there were insect species that were only found in flowering plants paper flower and marrigold but not found in the flowering plants yellow cosmos flower.
In Table 1.3 it can be seen that there were insects only found in flowering plants yellow cosmos flower planted. There were insects species that were only found in flowering plants paper flower planted. The species was Orthetrum trinacria, otherwise there were insect species not found in flowering plants paper flower but found in flowering plants yellow cosmos flower and marrigold.

3.4 Index of Diversity, Dominance and Evenness of Entomophage and Phytophage Insects on Flowering Plants Planted near Sugarcane Plantation aged 2 and 6 months

The result of the research showed that the diversity index, dominance index, and evenness index of phytophage and entomophage insect species on flowering plants planted near 2-month-old and 6-month-old sugarcane plantation was relatively the same. Based on the diversity index criteria, it can be seen that the diversity of phytophage and entomophage insect species in flowering plants planted near sugarcane plantations was relatively similar. (Table 4.4)
In Table 1.4 it can be seen that the dominance index value is smaller than 0.5 and the evenness index is greater than 0.5. This shows that there were no dominant entomophage and phytophage insect species. And it also shows that the spread of phytophage and entomophage insect species in flowering plants was relatively evenly distributed in flower plants planted near sugarcane plantations aged 2 months and 6 months old.

In Table 4.5 it can be seen that the number of individual species of phytophage insects in flowering plants planted near 2-month-old sugarcane plantations was more than entomophage insects. Conversely, the number of individual species of phytophage insects in flowering plants planted near the 6-month-old sugarcane crops was less than the entomophage insect species (Table 4.5).

Table 4.4 The index of diversity, dominance, and evenness of entomophage and phytophage insect species on flowering plants planted near the sugarcane plantation.

| Community Characteristics | On the flowering plants near the sugarcane crops… |
|---------------------------|-----------------------------------------------|
|                          | 2 months | Denomination | 6 months | Denomination |
| Number of individual (N)  | 388      | Individual   | 284      | Individual   |
| Diversity index (H')      | 3.433    | -            | 3.497    | -            |
| Dominance Index (D)       | 0.041    | -            | 0.035    | -            |
| Evenness Index (E)        | 0.735    | -            | 0.784    | -            |

In Table 4.5, it can be seen that the number of individual of entomophage insects in flowering plants near the 2-month-old sugarcane plants was less than the number of phytophage individual insects. However, in flowering plants that were planted near 6-month-old sugarcane plantations the number of entomophage insect individuals was greater than the number of phytophage insect individuals. This shows that sugarcane plantations aged 2 and 6 months planted with flowering plants can affect the number of entomophage insect individuals.

The result showed that the diversity of entomophage insect species on flowering plants in 2-month-old and 6-month-old sugarcane plantations was higher than that of phytophage insects. The number of individual phytophage insect species in flowering plants planted near 2-month-old sugarcane plantations was more than entomophage insects. Conversely, the number of individual species of phytophage insects in flowering plants planted near the 6-month-old sugarcane crops was less than the entomophage insect species (Table 4.5).

In Table 4.5, it can be seen that the number of individual of entomophage insects in flowering plants near the 2-month-old sugarcane plants was less than the number of phytophage individual insects. However, in flowering plants that were planted near 6-month-old sugarcane plantations the number of entomophage insect individuals was greater than the number of phytophage insect individuals. This shows that sugarcane plantations aged 2 and 6 months planted with flowering plants can affect the number of entomophage insect individuals.

The result showed that the diversity of entomophage insect species on flowering plants in 2-month-old and 6-month-old sugarcane plantations was higher than that of phytophage insects. The number of individual phytophage insect species in flowering plants planted near 2-month-old sugarcane plantations was more than entomophage insects. Conversely, the number of individual species of phytophage insects in flowering plants planted near the 6-month-old sugarcane crops was less than the entomophage insect species (Table 4.5).

Table 4.5 Index of diversity, dominance and evenness of phytophage and entomophage species in flowering plants that were planted near sugarcane plantations.

| Community Characteristics | insects in flowering plantations in sugarcane plants aged |
|---------------------------|----------------------------------------------------------|
|                          | 2 months | 6 months | 2 months | 6 months |
| Number of individual (N)  | 200      | 175      | 107      | 145      |
| Diversity index (H')      | 2.564    | 2.826    | 2.548    | 2.867    |
| Dominance Index (D)       | 0.096    | 0.073    | 0.089    | 0.067    |
| Evenness Index (E)        | 0.721    | 0.767    | 0.798    | 0.764    |

Table 4.6 Effect of diversity of flowers which were planted monoculturally on the presence of phytophage and entomophage insect species.

| Kinds of flower | 2 months | 6 months | 2 months | 6 months |
|-----------------|----------|----------|----------|----------|
|                 | Phytophage | Entomophage | Phytophage | Entomophage |
| Yellow Cosmos   | 32        | 36        | 26        | 47        | 141 |
| Marigold        | 10        | 10        | 8         | 18        | 46  |
| Bougainvillea   | 17        | 14        | 19        | 18        | 68  |
| Sum of Species  | 59        | 60        | 53        | 83        | 255 |

In Table 4.5, it can be seen that the number of individual of entomophage insects in flowering plants near the 2-month-old sugarcane plants was less than the number of phytophage individual insects. However, in flowering plants that were planted near 6-month-old sugarcane plantations the number of entomophage insect individuals was greater than the number of phytophage insect individuals. This shows that sugarcane plantations aged 2 and 6 months planted with flowering plants can affect the number of entomophage insect individuals.

The result showed that the diversity of entomophage insect species on flowering plants in 2-month-old and 6-month-old sugarcane plantations was higher than that of phytophage insects. The number of individual phytophage insect species in flowering plants planted near 2-month-old sugarcane plantations was more than entomophage insects. Conversely, the number of individual species of phytophage insects in flowering plants planted near the 6-month-old sugarcane crops was less than the entomophage insect species (Table 4.5).
Table 4.7 Effects of diversity of flowers that planted polyculturally on the presence of phytophage and entomophage insect species.

| Kinds of flowers   | 2 months |           | 6 months |           |          |          |
|--------------------|----------|-----------|----------|-----------|----------|----------|
|                    | Phytophage | Entomophage | Phytophage | Entomophage | Σ          |
| Yellow cosmos+ Bougainvillea | 26        | 30        | 23       | 27        | 106       |
| Bougainvillea+ Marigold   | 29        | 29        | 15       | 16        | 89        |
| Yellowcosmos+ Marigold    | 26        | 36        | 13       | 13        | 88        |
| K+M+K (Mix)             | 32        | 46        | 28       | 21        | 127       |
| Sum of Species         | 113       | 141       | 79       | 77        | 410       |

In Table 4.6 it can be seen that the insects found on Yellow Cosmos plants planted near sugarcane plantations aged 2 and 6 months were 55.3% more than on marigolds and bougainvillea flowers. Insect species found on marigold plants were 26.7% smaller than on bougainvillea, predicted it was influenced by the smell or aroma caused by marigold flowers. There were insects using eyes that only attracted to the yellow color. Yellow is a bright and bright color compared to other colors.

The results showed that the type of flowering plants that were planted polyculturally near sugarcane plantations aged 2 and 6 months could affect the species of phytophage and entomophage found. The number of entomophage insects was found more than phytophage insect species. In flowering plants planted near sugarcane plantations aged 2 months and 6 months, it was found that phytophage insect species and entomophage insect species were the same in number. (Table 4.6).

In Table 4.7, it can be seen that the insects found in the polyculture flowering plants (Yellowcosmos - Bougainvillea) planted near sugarcane plantations aged 2 and 6 months were 25.8% more than the Bougainvillea-Marigold and YellowCosmos-Marigold flowering plants. Phytophage insect species and entomofag insect species found in flowering plants that were planted near the 2 and 6 month old sugarcane plantations were 30.9% greater than the flowering plants above (Table 4.6). It shows that the more flowering plant population can affect the presence of insect species.

The results showed that the diversity index of entomophage species and phytophage insects in flowering plants planted near sugarcane plantations aged 6 months was higher with a value of 3.49 than flowering plants planted near sugarcane plantations aged 2 months with a value of 3.43. Research of [21] states that the diversity index can be used to express the relationship of species abundance in the community, the higher the diversity index, the better the relationship of species abundance in the community or stable.

The results showed that the dominance index of entomophage and phytophage insect species in flowering plants that were planted near 2-month-old sugarcane plantations and flowering plants that were planted near 6-month-old sugarcane plantations were 0.041 and 0.035 or the dominance is smaller than 0.5 which means that there were no entomophage insect species and phytophage insects species that dominate, or community structures were stable [22].

The results showed that the evenness index of entomophage insect and phytophage insects species on flowering plants planted near 2-month-old sugarcane plantations and on flowering plants that were planted near 6-month-old sugarcane plantations were 0.735 and 0.784 or E> 0.5 which means the evenness between relative species evenly distributed or the number of individuals of each species is relatively the same. According to [23] the evenness index ranged from 0 to 0.979, this figure shows that the individual existence of each species in a location were quite balanced.

4. Conclusion
1. Flowering plants that were planted near sugarcane plantations in 2-month-old and 6-month-old can affect the insect species entomophage and phytophage which comes to flowering crop.
2. The three types of flowering plants that were planted near sugarcane plantations in 2-month-old and 6-month-old, yellow cosmos flower are more effective the presence of entomophage and phytophage insects

5. Acknowledgement
We would like to thank for the PT. Perkebunan Nusantara VII Cinta Manis District.

References
[1] Araj, S. E. et al. 2009. Adding floral nectar resources to improve biological control: potential pitfalls of the fourth trophic level. Basic Appl. Ecol. 10: 554 – 562.
[2] Bista S and Shivakoti Gp. 2001. Honeybee Flora at Kabre, Dolakha District. Nepal Agricultural Research Journal, 4(5):18-25

[3] Direktorat Jenderal Perkebunan. 2009. Komoditas Tanaman Tebu. http://ditjenbun.deptan.go.id/budtansim/images/pdf/tebu.pdf.

[4] Freitas BM, Paxton RJ. 1996. The role of wind and insects in cashew (Anacardium occidentale) pollination in NE Brazil. Journal of Agricultural Science, 126: 319-26.

[5] Géneau C.E., Wäckers F.L., Luka H., Daniel C. & Balmer O.2012: Selective flowers to enhance biological control of cabbage pests by parasitoids. — Basic Appl. Ecol. 13: 85–93.

[6] Heimpel, G. E and Jervis, M. A. 2005. Does floral nectar improve biological control by parasitoids? In Plant-Provided Food for Carnivorous Insects: A Protective Mutualism and its Applications (pp. 267-304). Cambridge University Press.

[7] Hidayat P. 2015. Serangga dalam Kehidupan Manusia: Teman Sekaligus Lawan. [Prosiding Seminar Nasional]. Perhimpunan Entomologi Malang. 1-2:12

[8] Indriyanto. 2010. Ekologi Hutan. Bumi Aksara. Jakarta:210

[9] Kalshoven, L.G.E. 1981. Pest of Crops In Indonesia. Revised and translated by P.A. van der Laan. Jakarta: PT Ichtiar Baru- Van Hoeve.

[10] Kumar MAA, Hosamani V, Apparampure S. 2010. Biology of Sugarcane Intermediate Borer Chilo sacchariphagus indicus (Kapur), Karnataka Journal of Agricultural Sciences 23(1):140-41

[11] Magurran A E. 1998. Ecological Diversity and Its Measurant. Princenton University Press. New Jersey:256

[12] Nurindah, N., Sunarto, D.A., Sujak, S., 2016. Evaluasi pelepasan Trichogramma spp. Untuk pengendalian penggerek pucuk dan batang tebu. J. Entomol. Indonesia. 13: 107-116.

[13] P3GI. 2008. Konsep Peningkatan Rendemen untuk Mendukung Program Akserelerasi Industri Gula Nasional. Pasuruan, Indonesia. 26 hal.

[14] Pratama Z, Mardiansyah I, Zaini M. 2010. Pengaruh Kombinasi Waktu Pelepasan yang Berbeda antar Diatraeophaga striatalis Tns. dan Trichogramma chilonis terhadap Persentase Kerusakan Tanaman Tebu (Saccharum officinarum linn.) yang Disebabkan oleh Chilo auricilus Dudgeon

[15] Schaltegger S, Beständig U. 2012. Corporate Biodiversity Management Handbook: A Guide for Practical Implementation. BMU, Berlin. Summer J (ed). 2011. Asian Green City Index; Assessing the Environmental Performance of Asia’s Major Cities. Siemens AG, München, Germany.

[16] Shilpa P, Sowmya KS, Srikanth CD, Kuberappa GC. 2014. Pollinator diversity and foraging activity of fennel, Foeniculum vulgare Mill. and African marigold, Tagetes minuta L. Pest Management in Horticultural Ecosystems. 20(2):236-239.

[17] Siswoyo TA, Oktavianawati I, Sugiharto B, Murdiyanto U. 2006. Perubahan Kandungan Sukrosa dan Aktivitas Invertebrate pada Batang Tebu selama Pemanenan. J. Zuriat 17(2):132-138

[18] Siregar A S, Bakti D, Zahara F. 2014. Keane-karagaman Jenis Serangga Di Berbagai Tipe Lahan Sawah. Jurnal Online Agroekoteknologi . (2) 4:1640-1647

[19] Sukmawaty P, Herlinda S, Pujiastuti Y. 2008. Jenis-jenis Parasitoid Telur Eurydema Pulchrum (WEST.) (Hemiptera: Pentatomidae) pada Tanaman Brassicaceae. Prosiding Seminar Nasional Pengelolaan Organisme Pengganggu Tumbuhan dan Sumber Daya Hayati yang Berwawasan Lingkungan dalam Menyikapi Dampak Pemanasan Global, Palembang 18 Oktober 2008.

[20] Tim Penulis PTPN XI. 2010. Panduan Teknik Budidaya Tebu. PT Perkebunan Nusantara XI. Surabaya. 204 hlm.

[21] Ventakraman M. 2010. Indian insects and arachnids. Simova Education And Research: India:566

[22] Wan, N.F., Y.M. Cai., Y.J. Shen., X.Y. Ji., X.W. Wu., X.R. Zheng., W. Cheng., J. Li., Y.P Jiang., X. Chen., J. Weiner., J.X. Jiang., M. Nie., R.T. Ju., T. Yuan., J.J. Tang., W.D. Tian., H. Zhang, and B.L. 2018. Increasing Plant Diversity with Border Crops Reduces Insecticide Use and Increase Crop Yield in Urban Agriculture. eLIFE, 1-21.

[23] Wulandari A P,Atmowidi T, dan Kahono S. 2016. Peranan Lebah Trigona laeviceps (Hymenoptera: Apidae) dalam Produksi Biji Kailan (Brassica oleracea var. alboglabra). Jurnal Agron. 45(2):197-204