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Population stability of natural enemies arthopods in organic mustard planting that planted in organic and mineral lands

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Abstract

This study aims to compare the identification results of various types of natural enemy arthropods found in organic mustard grown on organic and mineral lands; analyzing the natural enemy arthropod community in terms of diversity, evenness, species richness and dominance in organic mustard planting that planted in organic and mineral lands; to analyze the comparative of the population stability of natural enemy arthropods in mustard planting that planted in organic and mineral lands. The research used the exploration method, namely by observing the organic mustard planting in organic and mineral lands. Then identification of the captured arthropods and natural enemy arthopod communities and analyzed the population stability of natural enemy arthropods in organic mustard that planted in organic and mineral lands. The results of this study are 1). The types of natural enemies found in organic mustard plants planted on organic land are more than in organic mustard plants grown on mineral lands. On organic land found 20 species of natural enemies, both predators and parasitoids, while on the mineral field, 17 species of natural enemies. 2). Diversity , evenness and species richness of natural enemy species were higher in mustard planted on organic land compared to mustard grown on mineral lands, while the dominance index of natural enemies in organic land is lower than in mineral lands. 3). The population stability of natural enemy arthropods was more stable in organic than on mineral lands.

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Introduction

Plant Pests is one of the important limiting factors in efforts to increase the production of mustard. Pest attacks occur at all stages of management of mustard starting from the nursery to the harvest. Vegetable growers are familiar with the names of mustard, such as *Plutella xylostella* L; *Spodoptera litura*., *Crocidolomia binotalis* Zell (Manueke *et al*., 2017). Efforts to minimize the economic losses of mustard farming due to plant pests attacks, in general farmers are still very dependent on the use of synthetic chemical pesticides, even though Integrated Pest Management has become a government policy. They still follow the conventional plant protection paradigm, preventive and insurance principles that tend to be excessive. Inappropriate and incorrect use of pesticides both types and dosages of their use often cause pest problems and pest outbreaks including pest resistance, pest resistance, secondary pest outbreaks, pesticide residues, and disturbance in human health. Increased consumer awareness of agricultural products that are safe for health and fitness, safe for occupational safety and health, safe for quality and environmental sustainability are encouraging the development of various technical requirements that products must be produced with technology that is familiar with the environment, and safe for human consumption.

By studying the structure of ecosystems, including the types and number of natural enemies, we can manage an agricultural ecosystem, especially organic mustard plants whose population is naturally controlled. Natural enemies that play an important role in suppressing pest populations are predators of the Arthopod phylum. Vegetable growers can actually empower biological agents in nature to control mustard pests. However, this has not been done because there are still many farmers who have not been able to distinguish between arthropod pests and natural enemy arthhopods as biological control agents in the field both on organic and mineral lands.

Population stability of natural enemy arthropods at an agroecosystem scale is very important because it affects the function of natural enemies in suppressing insect pest populations. In addition, the Integrated Pest Management (IPM) strategy is still focused on biological control, so information on the diversity of natural enemy arthropods in organic mustard plantations is needed to manage an agroecosystem that is economically profitable and ecologically sustainable.

Moving on from this background, it is necessary to conduct research on Population Stability Of Natural Enemies Arthopods In Organic Mustard Planting That Planted In Organic And Mineral Lands. The purpose of this study was (1) to compare the identification results of various types of natural enemy arthropods found in organic mustard grown on organic and mineral lands (2) analyzing the natural enemy arthropod community in terms of diversity, evenness, species richness and dominance in organic mustard planting that planted in organic and mineral lands; (3) to analyze the comparative of the population stability of natural enemy arthropods in mustard planting that planted in organic and mineral lands.

Materials and methods

Location

The study was conducted in the North Landasan Ulin Subdistrict, Liang Anggang District, Banjarbaru City (Organic Land); Gunung Kupang Banjarbaru (Mineral Land) and for identification of natural enemy arthopods were carried out at the Basic Laboratory of the Islamic University of Kalimantan Muhammad Arsyad Al Banjari Banjarmasin.

Materials and Tools

The ingredients used are Kumala brand mustard seeds, chicken manure, Bacillus thuringiensis, preservative alcohol, While the tools used are fit fall traps, sweppnet, light traps, yellow traps, label paper, small jars, brushes

Methods

The study used an exploratory method, namely by observing the organic mustard crop planted in organic wetlands and in mineral dry land

Implementation

Mustard seed is sown on the nursery, after 15 days of age is transferred to the experimental plot in organic

lands that have been given manure, pest attacks are controlled with *Bacillus thuringiensis*. Whereas for mineral land mustard seedlings that have been 15 days old were transferred to the experimental plot which had been given manure and pest control was carried out by the use of Bacillus thuringiensis.

Observation

Observations were made one week after the seedlings were transferred to the experimental plot both in organic wetlands and in mineral dry land and then observed in the second and third week.

Data analysis

To analyze the natural enemy arthopoda community, use:

1. Diversity index (H ') according to Shannon - Wiener (Southwood, 1978; Ludwig and Reynold, 1988)

$H = -\sum_{i=1}^{Sobs} pi \ln pi$

Where:

pi: ∑ni / N

H ': Shannon-Wiener Diversity Index

Pi: Number of individuals of a species / total number of all species

Ni: Number of individual species i

N: The total number of individuals

Criteria for diversity index according to Shannon modified by Suana and Haryanto (2007) are as follows:

Table 1. Range of values and species diversity level.

No	Diversity Value Range Species (H ')	Species Diversity Level
1	< 1	Very low
2	1 - < 2	Low
3	2 - < 3	Medium
4	3 - < 4	High
5	≥ 4	Very High

Source : Suana & Haryanto (2007)

2. Evenness index (E) according to Pilou (Ludwig and Reynold, 1988)

$E = \frac{H}{\ln S}$

Where:

H ': Diversity index

S : Kind of entirely

The range of evenness index between 0-1, the smaller the value of evenness (near zero) shows that the spread of the number of individuals of each type is not the same. Conversely, if the value of evenness is greater (close to 1) then the population will show evenness (the number of individuals per genus can be said to be the same or not much different) (Odum, 1993).

3. Richness index (R) according to Margalef (Ludwig and Reynold, 1988).

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

Where:

R = species richness index

S = Number of species

N = Number of individual species

Criteria for Type of Wealth Value (R) according to Magurran (1988) as follows:

Table 2. Range of values and level of richness type.

No	Range of Richness Value (R)	Level of Richness
1	< 3,5	Low
2	3,5 - 5,0	Medium
3	> 5	High

Source : Maguran (1988)

4. Domination Index (D) according to Simpson (Southwood, 1978; Ludwig & Reynold, 1988)

$D = \sum_{i=1}^{Sobs} (ni/N)^2$

Where:

D = Domination Index

ni = Number of individuals per species

N = Number of individuals of all species

Domination index ranges from 0-1, where the smaller the value of the dominance index (close to 0), it shows that there is no species dominating, whereas the greater the dominance index (close to 1), it indicates that there are certain species that dominate (Odum, 1993). To analyze the comparative diversity of natural enemy arthhopods on the mustard plant which is planted on organic land and the mustard plant which is planted on mineral soil is subjected to a T test.

Results and discussion

Identification of Different Types of Natural Enemy Arthopods

The results of capturing arthropods of natural enemies in the field either using fit fall traps, swaps

net, light traps, yellow traps on mustard plants planted on mineral land and mustard plants planted on organic land are then identified. Identification of natural enemy arthropods is done by observing physical or morphological characteristics using a microscope to species level by using the identification keys Boucek (1988) and Wegner (2011) whose results are as follows:

Based on Table 3. it can be explained that the type of natural enemies found in organic mustard planting that planted on organic land is higher than the types of natural enemies found in organic mustard plantings planted on mineral land. In the organic land found 20 species of natural enemies both predators and parasitoids while in mineral land found 17 species of mustard planted on organic land the population of natural enemies (predators and parasitoids) is higher than natural enemies found in mustard plants in planting in mineral land. Natural enemies are important factors in maintaining the balance of the ecosystem, therefore its existence needs to be maintained and preserved. These natural enemies need to be optimized as a natural control agent, among others by carrying out conservation so that the presence of these natural enemies can be used sustainably. One alternative is through the application of organic farming systems.

In general, it can be said that the presence of natural enemies from both predator and parasitoid groups is a significant potential in pest management in vegetable crops. Organic farming systems are able to conserve natural enemies in vegetable ecosystems, especially mustard plants (Murdan, & M. Sarjan. 2009). This is supported by Cheng (1995) Predators and parasitoids are a group of important natural enemies of pests, their role in the process of pest control. Through the role of insects as natural enemies, in addition to helping humans in pest control efforts, it also helps in maintaining the stability of food webs in an agricultural ecosystem.

Table 3. Results of identification of natural enemies caught on mustard plants planted on organic and mineral lands.

Organic Land				Mineral land			
Order	Family	Species	Status	Order	Family	Species	Status
Coleoptera	Carabidae	*Cicindelinae sp*	Predator	Coleoptera	Carabidae	*Cicindelinae sp*	Predator
Coleoptera	Coccinellidae	*Coccinella repanda* Thumberg	Predator	Coleoptera	Coccinellidae	*Coccinella repanda* Thumberg	Predator
Coleoptera	Coccinellidae	*Rodolia sp*	Predator	Coleoptera	Coccinellidae	*Rodolia sp*	Predator
Hemiptera	Miridae	*Phylus melanocephalus*	Predator	Hemiptera	Miridae	*Phylus melanocephalus*	Predator
Hemiptera	Pentatomi Dae	*Andrallus spinidens* F	Predator	Hemiptera	Pentatomi dae	*Andrallus spinidens* F	Predator
Hemiptera	Reduviidae	*Polididus armatissimus* Stal	Predator	Hemiptera	Reduviidae	*Polididus armatissimus* Stal	Predator
Hemiptera	Hebridae	*Hebrus bergrothi*	Predator	Hemiptera	Hebridae	*Hebrus bergrothi*	Predator
Hemiptera	Gerridae	*Limnogonus fossarum* Fabricius	Predator	Hemiptera	Gerridae	*Limnogonus fossarum* Fabricius	Predator
Diptera	Dolichopodidae	*Condylostylus sp*	Predator	Diptera	Dolichopodidae	*Condylostylus sp*	Predator
Araneae	Lycosidae.	*Pardosa sp*	Predator	Araneae	Lycosidae.	*Pardosa sp*	Predator
Araneae	*Agelenidae*	*Tegenaria parietena*	Predator	Araneae	*Agelenidae*	*Tegenaria parietena*	Predator
Araneae	Pisaudae	*Dolomedes tenobrosus*	Predator	Araneae	Pisaudae	*Dolomedes tenobrosus*	Predator
Neuroptera	Myrmeleonti Dae	*Myrmeleon formicarius*	Predator	-	-	-	-
Hymenoptera	Braconidae	*Cotesia kariyai*	Parasitoid	Hymenoptera	Braconidae	*Cotesia kariyai*	Parasitoid
Hymenoptera	Braconidae	*Chelonus munakatae*	Parasitoid	Hymenoptera	Braconidae	*Chelonus munakatae*	Parasitoid
Hymenoptera	Braconidae	*Microplitis plutellae*	Parasitoid	Hymenoptera	Braconidae	*Microplitis plutellae*	Parasitoid

Organic Land				Mineral land			
Order	Family	Species	Status	Order	Family	Species	Status
Hymenoptera	Braconidae	*Stenobracon nicevillei*	Parasitoid	Hymenoptera	Braconidae	*Stenobracon nicevillei*	Parasitoid
Hymenoptera	Cynipinae	*Rogas spp*	Parasitoid	Hymenoptera	Cynipinae	*Rogas spp*	Parasitoid
Hymenoptera	Ichneumonidae	*Trichomma cnaphalocrosis* Uchida	Parasitoid	-	-	-	-
Hymenoptera	Braconidae	*Cardiochiles philippinensis* Ashmead	Parasitoid	-	-	-	-

Analysis of the Natural Enemy Arthropod Community

The results of the analysis of the natural enemy arthopoda community both caught on organic mustard planting that planted on organic and on mineral lands are as follows:

Based on Fig. 1. it can be explained that on the organic land diversity index, the evenness index and the species richness index value are higher than in mineral land except the dominance index is higher in mineral land than in organic land. It can be explained that mustard plants planted in organic land have higher organic matter content than in mineral land (Table 4.). Indications of organic matter in the soil can be seen from organic compounds and N-Total so that it is obtained C / N ratio can be used to estimate the availability of nutrients from the mineralization of organic matter. The content of organic matter is the most important indicator in soil fertility. Organic matter has an important role as a trigger for soil fertility, both directly as a nutrient supply for authotrof organisms (plants) as well as a source of energy for heterotrophic organisms (fauna and soil microorganisms). Increased soil biological activity will encourage improvement in soil fertility, both physical, chemical and biological soil fertility. Improvement of physical, chemical and biological soil characteristics in line with the plant requirements of the target plants will be able to improve plant growth and production. While in mineral fields biophysical problems are factors that limit the productivity of land and plants in this agroecositem such as the sensitivity of soil to erosion, minimal nutrient content and limited organic matter content.

Arthopod diversity index (H ') of natural enemies in organic land is higher than in mineral fields. The higher the content of organic matter, the more fertile the plant has an impact on the high population of natural enemies found in the land causing a natural enemy diversity index higher than organic mustard plants planted on mineral land. These organic materials can be used as food arthropod soil. Ground arthopods themselves are food for arthropods of natural enemies, especially predators which result in better natural enemy life and a stable population between pests and natural enemies. According to Putri (2016), at a higher C-Organic content, the diversity index value is greater than the C-Organic whose value is lower. Odum (1993) which says that diversity is identical to the stability of an ecosystem, that is if the diversity of an ecosystem is high, then the condition of that ecosystem tends to be stable

The evenness index (E) value in organic land is higher than in mineral land, which means that the distribution of individual species of natural enemy arthopoda species is more evenly distributed in organic land. This is due to the better development of soil arthropods on organic land because the food in the form of organic material is more available in organic land compared to mineral land which subsequently results in an evenness index and a higher diversity index. According to Kartikasari, *et al.* (2015) that the smaller the value of evenness index or close to zero, the spread of an organism is not evenly distributed or within a community is dominated by certain types.

The value of the Arthopoda Species Richness Index (R) of natural enemies is higher in organic land (0.92) than in mineral land (0.74). The richness of natural enemies is an indicator of the many types of natural enemies in an organic mustard growing ecosystem.

This is presumably because in the area of organic mustard cultivation planted on organic land cumulatively the types of all natural enemy arthopods are higher than in mineral lad. The content of organic matter in organic land is higher thus triggering an increase in the diversity of decomposer arthropods. Arthopoda decomposer is a food of natural enemy arthopoda especially predator arthopoda. According to Latoantja *et al.* (2013) the high wealth of natural enemy arthropod species can increase the stability of the ecosystem so that it is not dominated by phytophages.

The dominance index (D) of natural enemy arthhopoda in organic land (D = 0.08) is lower than in mineral land (D = 0.09). This is due to the organic mustard plantings planted in mineral fields there is a tendency for certain types of natural enemy arthropods to dominate so as to obtain a high natural enemy population on certain natural enemy arthropods. The higher the dominance index the lower the evenness index and vice versa. The index value of the dominance of natural enemies illustrates the pattern of dominance of types of natural enemies in the community.

Organic vegetables have the potential to be developed in efforts to conserve natural enemies.

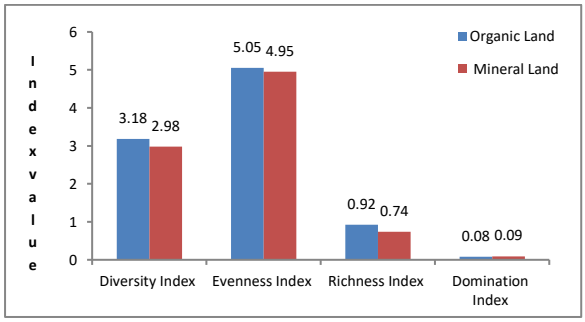

Fig. 1. Results of analysis of the natural enemy arthopoda community.

Table 4. Soil Analysis Results (Soil Laboratory, Plants, Fertilizers, Water Research and development Agency for Agriculture, 2017).

Soil Type	C-Org (%)	N(%)
Organic Land	3.676	0.422
Mineral Land	1.081	0.146

Comparison of Population Stability of Natural Enemy Arthopods in Organic Mustard Planting in Mineral and Organic Lands

The results of the t-test analysis used to compare the stability of the population of natural enemy arthropods in mustard greens planted in organic land with mustard greens planted on mineral soils found that the diversity index, evenness index and richness index of different types of natural enemy real compared to mineral soils (Table 5.). This explains that in organic land, the population of natural enemy arthropods is more stable than natural enemy populations in mineral soils and has more species and is more evenly distributed. The food web in organic land is more complex than on mineral soil. The tendency in organic land to have higher organic matter is understandable because besides the soil is rich in organic matter, it is added with the provision of fermented chicken manure. This organic material can be used as food for soil arthropods. Soil arthopods themselves become food for predatory arthopods which make the lives of natural enemies better and there is population stability between pests and natural enemies. This will result in a higher diversity of natural enemy arthhopods in organic land than in mineral soils. According to Henuhili and Tien (2013), if natural enemies are able to act as predators optimally from the start, the pest population can be at an equilibrium position or there will be stability between the pest population and its natural enemies so that there will be no pest explosion. Meanwhile, the dominance index in organic land was not different from that in mineral soils, which means that no specific natural enemy arthropods dominated. The higher the dominance index, the lower the evenness index and vice versa. The dominance index value of natural enemies illustrates the dominance pattern of natural enemy types in the community.

Table 5. Recapitulation of the results of the t test analysis.

No	Natural enemy arthropod community structures	Sig. (2-tailed)
1	Diversity Index (H')	0.00*
2	Richness Index (R)	0.03*
3	Evenness Index (E)	0.00*
4	Dominance Index (D)	0.58

Note : (*) shows a real difference based on the t test at 5% significant level.

Conclusion

Based on the results and discussion, the following conclusions can be drawn:

1. The types of natural enemies found in organic mustard plants planted on organic land are more than in organic mustard plants grown on mineral land. On the organic land, there were 20 species of natural enemies, both predators and parasitoids, while on the mineral land, 17 species were found.
2. Diversity Index, Evenness Index and Wealth Index for natural enemy types were higher in organic mustard greens grown on organic land compared to organic mustard greens grown on mineral land. Moderate, the dominance index of natural enemies in organic land is lower than in mineral land.
3. Population stability of natural enemy arthropods is more stable in organic land than on mineral land.

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