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Insect Pests Diversity in Organic Edamame Cultivation with Application of Kiambang Bokashi

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Abstract
Edamame soybean have a higher selling value compared to other soybeans and have good prospects. One of the inhibiting factors in edamame cultivation is pest infestation. Pest infestations can result in up to 80% loss of edamame crops. Plants that lack nutrients will be susceptible to pests. The application of bokashi kiambang fertilizer is one of the efforts to provide sufficient nutrients for edamame soybean plants. Calculation of insect pest diversity is very important to obtain information that can be used in making decisions on pest control measures. The purpose of this study was to determine the level of insect diversity in organic edamame cultivation used bokashi kiambang. This study used Randomized Block Design (RBD), with the treatment given being kiambang bokashi with five levels of treatment, namely 0 kg/plot, 2 kg/plot, 4 kg/plot, 6 kg/plot, and 8 kg/plot. The results of the study showed that the difference in the dose of bokashi kiambang had no effect on the diversity of insect pests. However, it can be known that the diversity index (H') of insect pests has a status of moderate level of species diversity (1 < H' < 3), the dominance index (C) of insect pests has a status of low dominance status (C ≤ 0.5) to high (C ≥ 0.5), the equality index (E) of insect pests has a status of high level of population uniformity (E > 0.6, and the type richness index (R) of insect pests has a status of low type richness level (R< 2.5).

Keywords: *Glycine max, Salvinia molesta, Pest*

1. Introduction

Edamame (*Glycine max* (L.) Merill) is a type of soybean that originated in Japan and was harvested when it was young and green. Edamame are edible and have a higher selling value compared to other soybeans. Edamame have a wide market, especially from America, Korea, China, Japan, Taiwan, Australia, and so on. Edamame cultivation is still relatively small, while the market is very large. The market demand in Japan for edamame reaches 100,000 tons/year and the United States reaches 7,000 tons/year. Indonesia can only meet the needs of the Japanese market, which is 3% and the remaining 97% is met by China and Taiwan [1].

Edamame cultivation in South Kalimantan has an average production over the last five years (2014-2018) of 24,647 tons with soybean productivity of 1.38 tons/ha, while the national productivity of soybeans reaches 1.71 tons/ha. Productivity in South Kalimantan is still relatively

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low [2]. Edemame have several advantages, namely a larger seed size, with a sweet and savory taste, a softer texture than other soybeans, a faster production period and a harvest period of 63-68 days, high protein content and high productivity [3]. Edamame cultivation business with organic farming practices will get better quality results. The concept of organic farming is not only improving soil properties but also safe for the environment and can be used as local waste for farmers [4]. The concept of edamame cultivation using organic agriculture is one of the solutions to various potential problems in the long term due to the continuous and excessive use of inorganic fertilizers [5].

One of the problems faced by farmers in cultivating edamame soybeans is the presence of insect pest attacks. Edamame can be attacked by pests from the beginning of growth to harvest time. Pest attacks on edamame soybeans can result in up to 80% loss of edamame crops. Insect pests have activities that have the potential to cause losses in an agroecosystem, either because their activities are directly or indirectly damaging to plants [6]. Important pests that often cause losses to soybean plants are bean seed flies (*Ophiomyia phaseoli*), bean stem flies (*Melanagromyza sojae*), soybean root (*Melanagromyza dolichostigma*), fireworms (*Agrotis spp*), soybean aphids (*Aphis glycines*), silverleaf whitefly (*Bemisia tabaci*), leaf beetles (*Phaedonia inclusa*), armyworms (*Spodopthera litura*), caterpillar (*Chrysodeixis chalcites*), leaf roller (*Lamprosema indicata*), pod borer (*Etiella spp*), *Riptortus linearis*, *Nezara virudula*, and legume stink bugs (*Piezodorus hybneri*) [7].

Plants that lack nutrients can make them vulnerable to pest attacks. However, excessive fertilization can result in plants collapsing, suboptimal production and sensitivity to pest and plant disease attacks [8]. Organic fertilizers are fertilizers that can repair damage to soil properties and increase soil fertility. One type of fertilizer used is bokashi fertilizer [9]. Bokashi is a type of fertilizer that can replace inorganic fertilizers. The advantage of bokashi fertilizer is that the nutrient content is higher than other fertilizers, resulting in a faster growth process period in plants, the energy lost is low and the population of microorganisms in the soil is much better [10]. Bokashi as a decomposer can accelerate the process of decomposition of organic matter in the soil, so that it can increase the nutrients N, P and K for plants and influences the process of photosynthesis [11]. In making bokashi you can use materials such as kiambang (*Salvinia molesta*) [12]. The content of kiambang fertilizer has nutrients N of 2.43% (high), P of 0.12% and K of 0.18% as well as micronutrients [13].

Calculation of insect pest diversity is very important to obtain information that can be used in making decisions on pest control actions. The diversity index (H'), dominance index (C), species richness index (R) and evenness index (E) are parameters needed to analyze the structure of a community [14] [15]. Based on the explanation above, it is necessary to conduct further research on the diversity of insect pests in organic edamame soybean cultivation (*Glycine max* (L.) Merill) with the application of kiambang bokashi by calculating the diversity index, dominance index, evenness index, and insect species richness index. The purpose of this study was to determine the level of insect diversity in organic edamame cultivation with the application of kiambang bokashi.

2. Material and Methods

The materials used are edamame seeds of the Ryokkoh-75 variety, kiambang, banana stem, chicken manure, EM4, brown sugar, bran, humus, husk charcoal, water, dolomite lime, alcohol 70%, and detergent. The tools used were hoes, tape measure, scale, tarpaulins, watering can, stationery, cameras, yellow paint, sweep nets, pitfall traps, yellow traps, sample bottles, digital USB microscopes, insect determination keybooks, and millimeter block books.

This study used a one-factor Randomized Block Design (RBD), with the treatment given being bokashi kiambang which consisted of five levels of treatment, namely: k_0 : 0 tons/ha (Control); k_1 : 5 tons/ha equivalent to 2 kg/plot; k_2 : 10 tons/ha equivalent to 4 kg/plot; k_3 : 15 tons/ha equivalent to 6 kg/plot; k_4 : 20 tons/ha is equivalent to 8 kg/plot. The treatment was repeated five times, so that 25 experimental units were obtained.

The implementation of the research consists of several stages, namely: making kiambang bokashi, land processing, seed selection, application of kiambang bokashi fertilizer, planting seeds, plant maintenance, and harvesting. Observations were carried out 1 time every week starting from week 1 to week 9 after planting, counting at the age of 7, 14, 21, 28, 35, 42, 49, 56 and 63 days after planting (DAP). Sampling of insect pests is carried out with several traps, namely sweep nets, pitfall traps and yellow traps. Identify the caught insect using the help of a digital USB microscope. The observed parameters, namely:

1. Diversity index (H') [16]

$$\boldsymbol{H'} = -\sum(\text{Pi})(\ln \text{pi}) \quad (1)$$

$$\text{Pi} = -\sum\left(\frac{ni}{n}\right)\boldsymbol{ln}\left(\frac{ni}{n}\right) \quad (2)$$

Information:
H’ = Diversity Index.
Ni = Number of individuals.
n = Total number of individuals.

Criteria:

H' < 1 = Shows a low level of species diversity.
1 < H' < 3 = Indicates a moderate level of species diversity.
H' > 3 = Shows a high level of species diversity.

2. Dominance Index (C) [17]

$$\text{C} = \sum\left[\frac{\text{ni}}{\text{N}}\right]2 \quad (3)$$

Information:
C = Dominance index.
Ni = Number of individuals.
N = Total number of individuals.

Criteria: The greater the dominance index value (C), the greater the tendency for a certain type to dominate.

3. Evenness Index (E) [17]

$$\text{E} = \frac{H'}{\ln S} \quad (4)$$

Information:
E = Evenness index.
S = Number of species.
H’ = Diversity index.

Criteria:

E < 0.4	= Uniformity of small populations.
0.4 < E < 0.6	= Moderate population uniformity.
E > 0.6	= High population uniformity.

4. Species Richness Index (R) [18]

$$R = \frac{S-1}{ln\, N} \quad (5)$$

Information:
R = Index of type richness.
S = The total number of species in a habitat.
N = Total number of individuals.

Criteria:

R< 2.5	= Indicates a low level
2,5 < R < 4	= Indicates medium level
R > 4	= Indicates a high level

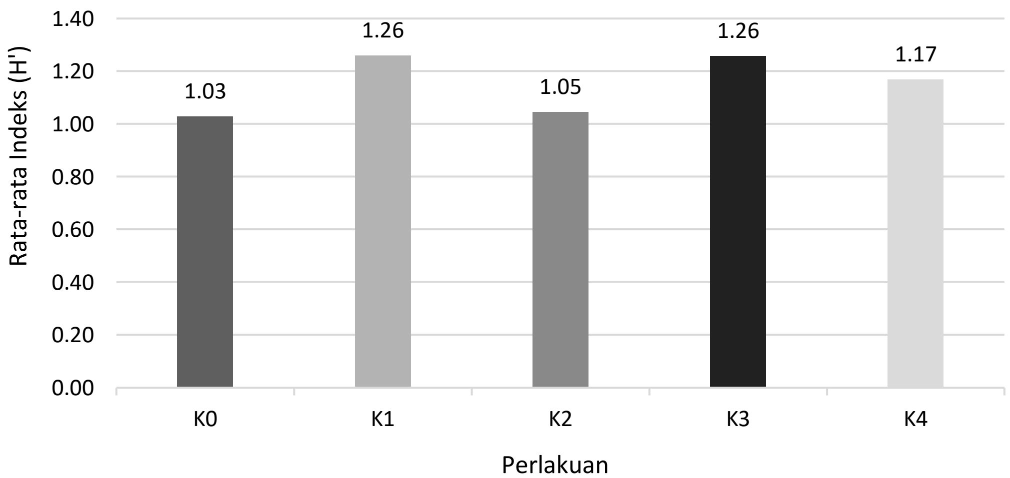
The observation data were tested for homogeneity using Barlett's Homogeneity of Variance Test. Then, ANOVA (Analysis of Variance) analysis was carried out to determine whether or not there was an effect of the treatment given.

3. Results and Discussion

3.1 Results

3.1.1 Diversity Index (H')

The average value of the diversity index (H') of insect pests in each treatment can be seen in Figure 15 showing that the treatment $k_{1,}$ k3, k4, k2 and k_0 means that it has a moderate level of species diversity status (1 < H' < 3).



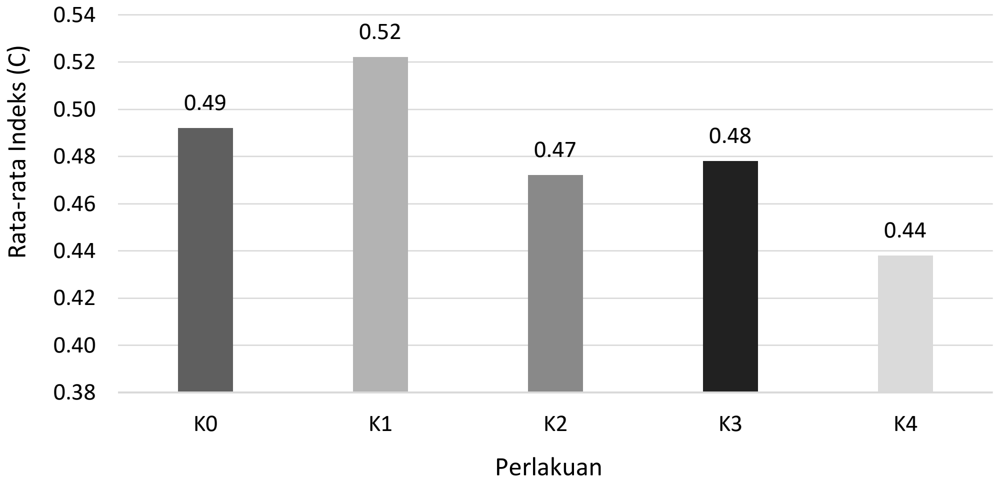
Description : k0 : 0 tons/ha (Control); k_1 : 5 tons/ha equivalent to 2 kg/plot; k_2 : 10 tons/ha equivalent with 4 kg/plot; K3: 15 tons/ha equivalent to 6 kg/plot; K_4 : 20 tons/ha equivalent to 8 kg/plot

Figure 1

Histogram of the average diversity index (H') of insect pests in each treatment

3.1.2 Dominance Index (C)

The average value of the dominance index (C) of insect pests in each treatment can be seen in Figure 17 showing that the k_1 treatment has a high dominance status (C ≥ 0.5), while the $k_{0,}$ k3, k2 and k4 treatments have a low dominance status (C ≤ 0.5).

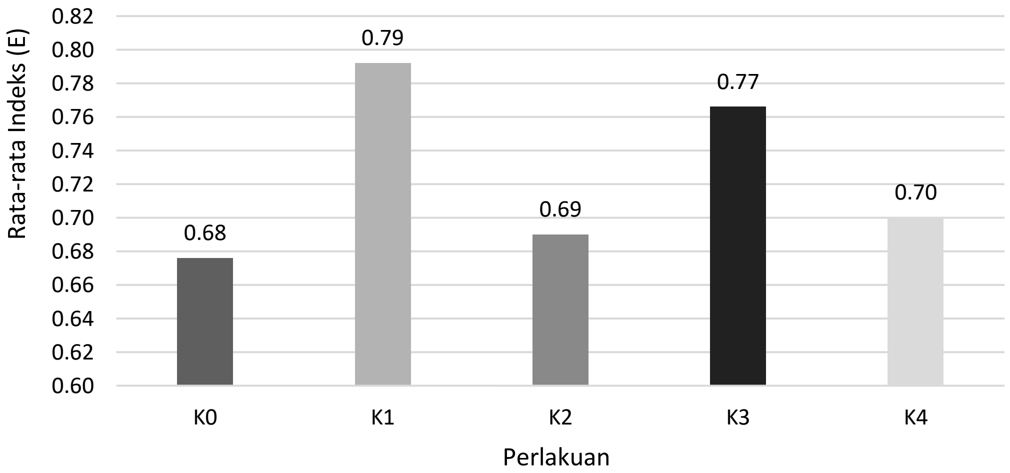


Description : k0 : 0 tons/ha (Control); k_1 : 5 tons/ha equivalent to 2 kg/plot; k_2 : 10 tons/ha equivalent with 4 kg/plot; K3: 15 tons/ha equivalent to 6 kg/plot; K_4 : 20 tons/ha equivalent to 8 kg/plot

Figure 2
Histogram of the average dominance index (C) of insect pests in each treatment

3.1.3 Evenness Index (E)

The average value of the evenness index (E) of insect pests in each treatment can be seen in Figure 20 showing that the treatment $k_{1,}$ k3, k4, k2 and k0 has a high level of population uniformity status (E > 0.6).

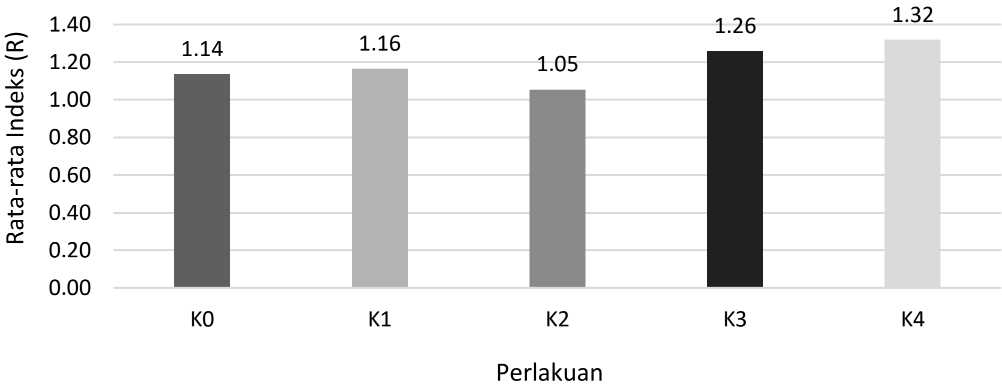


Description : k0 : 0 tons/ha (Control); k_1 : 5 tons/ha equivalent to 2 kg/plot; k_2 : 10 tons/ha equivalent with 4 kg/plot; K3: 15 tons/ha equivalent to 6 kg/plot; K_4 : 20 tons/ha equivalent to 8 kg/plot

Figure 4
Histogram of the average evenness index (E) of insect pests in each treatment

3.1.4 Species Richness Index (R)

The average value of the species richness index (R) of insect pests in each treatment can be seen in Figure 18 showing that the treatment k_4, k3, k1, k0 and k2 have a status of low type richness level (R< 2.5).



Description : k0 : 0 tons/ha (Control); k_1 : 5 tons/ha equivalent to 2 kg/plot; k_2 : 10 tons/ha equivalent with 4 kg/plot; K3: 15 tons/ha equivalent to 6 kg/plot; K_4 : 20 tons/ha equivalent to 8 kg/plot

Figure 3

Histogram of the average species richness index (R) of insect pests in each treatment

3.1.5 Insect Pest Population

The number of pest insect populations found on edamame plants given the bokashi kiambang can be seen in Table 1. There are 14 species of insects with 861 individuals found.

Table 1.

The number of pest insect populations found on edamame plants given the bokashi kiambang

No.	Ordo and Famili	Spesies	K_0	K_1	K_2	K_3	K_4	Amount
	Homoptera							
1	Aleyrodidae	*Bemisia tabaci*	9	2	9	3	5	28
	Coleoptera							
2	Chrysomelidae	*Aulacophora indica*				3		3
3	Chrysomelidae	*Chrysochus asclepiades*			1		2	3
4	Scarabaeidea	*Adoretus compressus*	2	3		6	1	12
5	Carabidae	*Pheropsophus occipitalis*	8	11	9	11	9	48
	Diptera							
6	Tephritidae	*Bactrocera papayae*	118	144	105	117	121	605
	Isoptera							
7	Rhinotermitidae	*Coptotermes curvignathus*	13	14	8	4	30	69
	Lepidoptera							
8	Pyralidae	*Lamprosema indicata*				1		1
9	Tineidea	*Tineola bisselliella*	1				1	2
10	Erebidae	*Amata huebneri*				1		1
11	Noctuidae	*Spodoptera litura*	10	3	15	15	15	58
	Orthoptera							
12	Gryllidae	*Tarbinskiellus portentosus*	3	4	8	2	1	18
13	Acrididae	*Valanga nigricornis*		3	3	1	5	12
	Hemiptera							
14	Coreidae	*Leptocorisa acuta* Thunberg.					1	1
		Total	164	184	158	164	191	**861**

3.2 Discussion

Based on the results of the analysis of the variety of fertilizer application, bokashi kiambang did not have a significant effect on the value of the diversity index (H'), dominance index (C), species richness index (R) and evenness index (E) of insect pests. The presence of insects is used as an indicator of ecosystem balance, where if the diversity of insect pests in an ecosystem is high, then the ecosystem environment is said to be balanced or stable and the food chain process runs normally, while if the diversity of insect pests in an ecosystem is low, then the ecological environment becomes unbalanced or unstable.

Diversity in nature can change as a result of four parameters, namely the diversity index (H'), the dominance index (C), the type richness index (R) and the evenness index (E) [19]. On the other hand, it is suspected that there are environmental factors that can affect the diversity of insect pests. The diversity of insect pests is closely related to activity patterns in conditions of attachment to biotic and abiotic environmental factors such as air temperature, air humidity and rainfall [20]. At the time of the study, there were abiotic factors such as air temperature in December 2023 – February 2024 ranging from 26.9 – 27.4°C. The ideal temperature for insect pests is at a susceptibility between 15-45°C, insects can die if they exceed this temperature [21]. Therefore, it is stated that the ability of insects with the optimum temperature range can increase reproductive numbers and reduce premature deaths.

Air humidity in December 2023 – February 2024 ranges from 73% – 98%. It is suspected that high air humidity will affect the development of pests. Air humidity for insects generally ranges from 73% to 100%, meaning that air humidity has an effect on insect biological processes, with this range included in optimal humidity and humidity fluctuations also play a major role in regulating organism activity and insect spread [22]. Too high or too low air humidity can hinder the activity and life of insects, except that there are some types of insects that usually live in wet places, while the optimum humidity of insects differs from the type and level of life at each development.

Rainfall in the research field ranges from 284 mm to 515 mm which is included in the medium to very high category. If there is high rainfall, many insect pests die as a result of continuous rain, affecting the population in the field. Directly high rainfall will reduce the population of insect pests because some insect individuals are washed away by heavy rainfall, the abundance of insect pests is optimal in rainfall which ranges from 200 mm – 300 mm [23].

The diversity index (H') in all treatments had a moderate species diversity status of $1 < H' < 3$. The criteria for a "moderate" species diversity index if $1 < H' < 3$. Ecosystem environments that have environmental disturbances or influences, species diversity is included tends to be moderate [24]. A community will have a high level of diversity, if there are many species in a community with a balanced state [25]. But if a community has low diversity, then there are few species in that community or there are only a few species that dominate.

The dominance index (C) in all treatments had a dominance index value close to 1 or exceeds $C \geq 0.5$, then there are types of pests that dominate and the situation becomes unstable. If the index value is close to 0 then no species dominates, while the value is close to 1 then there are dominant species [26]. In the treatment of k_0, k3, k2 and k4 had low dominance pest status because the index value is close to 0 or $C \leq 0.5$. This means that there were no types of pests that dominate in the edamame planting area and are in a stable state. Insect pests around the organic edamame soybean planting area can be spread evenly in each treatment.

The evenness index (E) in all treatments had a high level of population uniformity. The high equality results indicate that no population is dominant. The value of equality will be high if the number of population in one family does not dominate the other families, while equality will be of low value if there is a family that has a dominating number of the total population [27].

The type richness index (R) in all treatments had a criteria of low type richness level or R < 2.5. It is suspected that there are only a few types of insect pests in the research area. Although it still does not reach the great criteria to get out of the status of low species richness, the high and low level of pests can be influenced by how many types of pest species exist compared to how many populations of each species are. If the species richness index is small, then the species found is also low [28].

Abiotic factors such as land conditions are also factors that affect the emergence of pests from the vegetative to generative phases. The diversity of insect pests shows that in the observation of the first week to the ninth week (weeks after planting/WAP) the condition of the land in the Mount Kupang Agricultural Area experienced rainwater. This condition causes a low population of insect pests in organic edamame soybean plantations, so that the environment can adjust to the presence of these pests [29]. In addition, it is suspected that the presence of other plants around the study area may affect the level of diversity and population of insect pests where the insects also spread to areas outside the study area [30].

The results of the observations showed that there were 14 species found in the study area, namely *Pheropsophus occipitalis, Chrysochus asclepiades, Aulacophora indica, Adoretus compressus, Bactrocera papayae, Leptocorisa acuta* Thunberg., *Bemisia tabaci, Coptotermes curvignathus, Spodoptera litura, Lamprosema indicata, Amata huebneri, Tineola bisselliella, Valanga nigricornis and Tarbinskiellus portentosus.* Observation data shows that *Bactrocera papayae* is the species most frequently found in each treatment. *Bactrocera* sp. is a type of pest that is known to have many host plants so it is often found on various types of plants with quite large populations [31].

4. Conclusion

The results of the study showed that the difference in the dose of bokashi kiambang had no effect on the diversity of insect pests. However, it can be found that the diversity index (H') of insect pests has a status of moderate species diversity (1 < H' < 3), the dominance index (C) of insect pests has a low (C ≤ 0.5) to high (C ≥ 0.5) dominance status, the equality index (E) of insect pests has a status of a high level of population uniformity (E > 0.6), and the species richness index (R) of insect pests has a status of low type richness level (R< 2.5).

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