*Agrium ISSN 0852-1077 (Print) ISSN 2442-7306 (Online)*
*April 2024 Volume 27 No.1*

# Effect Biopesticides of Fungi Entomopathogenic on the Damage Intensity of Edamame Soybean

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***Abstract***

*Biopesticides as an alternative to synthetic pesticides are rarely at the field testing level. The research described the composition of pest types and compared the intensity of plant pest attacks in edamame soybean cultivation areas. The study used a Randomized Block Design with biopesticide or entomopathogenic fungus treatments. The active ingredients consisted of L. lecanni, B. bassiana, and M. anisopliae, and the active ingredients were synthetic chemical compounds (control). Each treatment was repeated six times to obtain 24 experimental plots. The research analyzed growth and vegetative phases, pest composition, and intensity of pest attacks. Data analysis used the Kruskall-Wallis and Wilcoxon tests. The results showed that the control treatment had the highest plant height, number of productive branches, pods, and fresh seed. Furthermore, the pest composition comprises leaf-destroying pests: armyworms, grasshoppers, and pod-sucking ladybugs. The lowest level of leaf damage occurred two weeks after planting (MBS) on B. Bassiana plants. Meanwhile, M. anisopliae at 4 and 6 WAP, then L. lecanni at 8 WAP with damage of 16.69, 18.59, 20.88, and 20.24%, respectively. There were differences in leaf damage in the control and B. bassiana and M. anisopliae at 2 WAP. However, synthetic pesticides are more effective in suppressing pod damage than biopesticides. The findings of this research show that biopesticides are an alternative, but their effectiveness cannot exceed synthetic pesticides in edamame soybean cultivation.*

***Keywords:*** *Alternative pesticides, leaf damage, pods damage, pest of insect, pest control.*

**Received:** 15 December 2023**; Revised:** 04 February 2024**; Accepted:** 24 April 2024

## INTRODUCTION

Edamames are soybean (*Glycine max* L.) having a lot of nutrition. Based on the size of the seeds, edamame soybeans are more significant than regular soybeans, namely more significant than 30 g per 100 seeds. Edamame is a low shrub plant with dense leaves, and the height of edamame reaches 30 cm to more than 50 cm, depending on the variety and living environment. Edamame soybean branches can be few or many depending on the variety and environmental conditions. Furthermore, edamame soybeans are a nutritious snack that benefits body health. This plant has relatively high levels of vitamin C and fiber. It also contains amino acids: isoleucine, leucine, lysine, phenylalanine, tyrosine, methionine, cystine, threonine, tryptophan, and valine (Samsu 2003). This plant also contains antioxidants and isoflavones, which reduce the risk of cancer, lower blood pressure, prevent heart disease, and other benefits (Hakim, 2013).

Like other types of soybeans in general, this plant also experiences several disturbances by plant pest organisms from the variety of pest group. There are several pests on soybean plants, aphids, leafhopper, bean bettle, stink bugs, and lepidopteran larvae (Lord et al., 2021). Rahayu et al. (2020) reported six main pests of soybean plants, that were the soybean leaf beetle (*Phaedonia inclusa*), green ladybug (*Nezara virudula*), pod-sucking ladybug (*Riptortus linearis* L), spanworm caterpillar (*Chrysodeixis*

10.30596/agrium.v27i1.17791

*chalcites*), Pod borer caterpillar (*Etiella zinckenella*), and leaf roller (*Lamprosema indicate*). Also, *Bemisia tabaci* and *Spodoptera* spp are one of pest on edamame soybean (Rohman & Haryadi, 2020). The intensity of pest attacks on edamame plants varies. Several reports showed that the attack intensity of leaf-destroying pests was between 36.66 and 50.28%, and the percentage of attacks reached 22.34 to 37.44% (Hakim et al., 2022). Especially *Bemisia tabaci* can cause yield losses reaching 80-90% (Cruz et al., 2016), pod-sucking ladybugs reached 80-100% (Li et al., 2021), and armyworms reached 22-25% (Babu et al., 2018).

Pest control is carried out using various methods. The use of control using biological agents is still very rarely used to control pests in soybeans. Based on the results of the tile survey 2020, the most common method of controlling pests used by soybean households is syntehetic chemical control at 89.55%, followed by agronomic/technical culture, namely 8.43%. Specifically, mechanical and biological controls in controlling pest attacks amounted to 1.62% and 0.40%, respectively (BPS 2021). Dependence on synthetic pesticides can harm edamame products, which we know are generally consumed directly (e.g snacks). According to Rahim et al. (2021), excessive pesticides can leave residue on plants and endanger human health. Apart from that, there are also side effects such as ecosystem damage, resistance, resurgence, and triggering pest explosions. Biological control is one of the alternatives to reduce these harmful effects. The principle of biological control is to control plant pests by exploiting their natural enemies and using biological agents such as predators, parasitoids, and entomopathogens (Ayilara et al., 2023).

Efforts to increase the use of biological agents as pest control can be made by conducting various field tests. The biological control using fungal microorganisms is an alternative pest control (El-Saadony et al., 2022). Then, there are several types of fungi as biological agents in controlling pests (entomopathogens) in soybean plants, namely the fungi *Beauveria bassiana*, *Lecanicillium lecanii*, and *Metarhizium anisopliae Paecilomyces fumosoroseus*, *Nomuraea rileyi*, and *Spicaria* sp (Prayogo 2005, Widariyanto et al. 2017).The results of testing several types of entomopathogenic fungi were reported to have the ability to increase mortality. Widariyanto et al. (2017) reported that *L. lecanii* and *M. anisopliae* effectively suppressing the *A. glycines* population, as indicated by a high mortality rate and a faster death time compared to other treatments. The another study were reported that the concentration of B. bassiana fungus treatment on *R. linearis* significantly affected the percentage of mortality and the number of infected *R. linearis*, even though the mortality of *R. linearis* was relatively low with around less than 50%.

Entomopathogenic fungi are generally tested on a laboratory. Meanwhile, its still needs use to be improved in edamame soybean cultivation areas. Specifically, for entomopathogenic pesticide are not developed in edamame soybean plants, such as Tarakan Island, North Kalimantan. Another challenge is the lack of information about the types of soybean plant pests that exist in Tarakan Islands, as well as opportunities for utilizing entomopathogenic fungi, which are essential aspects that need to be researched.

## MATERIALS AND METHODS

### Study Sites

The research was carried out in East Mamburungan sub-district, Tarakan North Kalimantan Also, researchers were used Plant Protection Laboratory, Agriculuture Faculty Borneo University, Tarakan.

### Experimental Design

The research was exined using an experimental study with a randomized completely block design (RCBD). The treatment consisted of three types of biopesticides containing active ingredients from entomopathogenic fungi, namely the biopesticide fungi *L. lecanii*, *B. bassiana*, and *M. anisopliae* and without biopesticide treatment or using synthetic pesticides (no biopesticides). Each treatment was repeated six times to obtain 24 experimental plots or units.



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**Research Procedure**

Land processing cleared, which used a hoe. The land was cleared of various nuisance plants or weed. Land was cleaned then processed and formed into beds measuring 100 cm x 100 cm with a total of 24 beds and a distance between beds of ± 50 cm. After the soil bed was formed, manure and straw mulch were given to cover the soil from rainwater runoff and maintain soil moisture. Before planted, the seeds were given an application of Rhizobium. The amount given was 10 grams per 100 seeds. After that, the seeds were planted with a spacing of 30 x 15 cm (15 populations per bed).

The researchers were replanted out 9-14 days after planting and replaced plants that die or grow abnormally. We also watered the plants twice a day when there was no rain. Furthermore, fertilization was used inorganic fertilizer. There was given as recommended, and basic fertilizer was used, SP-36 200 kg/ha or 1.08 kg/plot. Additional fertilization was carried out when the plants were 10 HST, with KCL fertilizer 50 kg/ha or 0.27 kg/plot and urea 150 kg/ha or 0.81 kg/plot. The second supplementary fertilization was carried out when the plants were 21 days after planting that consisted of KCL 100 kg/ha or 0.54 kg/plot, Urea 50 kg/ha, or 0.27 kg/plot.

Weed control was carried out on weeds around that the straw mulch was pulled by directly. Also, they grew around the plants so that they do not become competitors for the plants in absorbing nutrients. In addition, we dumped the bed, which was done after additional fertilization at ± 25 days after planted by loosening the soil around the stem. Backfilling was done by raising the soil between the beds to the surface of the beds between the rows of plants. Edamame soybeans were harvested when the plants are around 63 days after planting or R6 phase, namely, the pod contains one green seed that fills the pod cavity in one of the top 4 segments on the main stem, and the leaves are fully open (Samsu, 2003).

**Application of Entomopathogenic Fungal Biopesticides**

The biopesticide applied was adjusted to the dosage stated on the packaging of each product. Applying bioinsecticides was done using a sprayer by spraying the leaves on all edamame soybean plants seven times at an interval of seven days and in the afternoon. Meanwhile, control was carried out using insecticides containing the active ingredients emamectin benzoate and lufenuron at the recommended dosage.

**Research Parameters**

We observed and identified the types of pests that attack soybean plants. Observations were made every week before application until harvest time. The percentage of attacks was observed by looking at the symptoms on the edamame leaves. The damage to leaves was observed visually/directly on each plant sample. Each plant leaf is given a score for healthy plants and those with severe damage, as in Table 1.

**Table 1. Assess the Leaf Damage Scale.**

| Score intensity | Number of damaged leaves (%) |
|---|---|
| 0 | 0 |
| 1 | 0 – 20 |
| 3 | 21 – 40 |
| 5 | 41 – 60 |
| 7 | 61 – 80 |
| 9 | 81 - 100 |

Source: Directorate General of Food Crops (2018).

Leaf damage was calculated using the non-absolute pest attack intensity formula. The intensity of damage (*IS*) is described by adding up the number of samples-i ($n_i$) multiplied by the scale value of-i samples ($z_i$) and dividing it by multiplying the number of all plant samples (N) that have the highest score (*Z*) (Directorate General of Food Crops, 2018). The formula is as follows

$$IS = \frac{\sum(ni \times vi)}{Z \times N} \times 100\%$$



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Vegetative parameters consisted of (1) measurement of the height plant which the sample plants measured from the root collar to the tip of the highest leaf using a meter for two weeks after planting (WAP), and the flowering plants reached the age of 4 WAP; (2) the number of productive branches counted were the branches originating from the main stem of each plant.

There were the number of empty pods and the level of pod damage for absolute damage. This damage was explained by counting the number of damaged or empty pods divided by the number of pods observed and the number of damaged or empty pods. The formula is as follows,

$$I = \frac{a}{a+b}\ x\ 100\%$$

Where *I*=intensity of of pod damage , *a*=number of empty pos, and *b*= number of pods observed

Generative parameters have consisted (1) number of pods per sample plant, observations were made on all pods formed in each experimental unit that observed at harvest; (2) the number of empty pods is counted for each plant, namely empty pods, carried out when the plant was harvested; (3) The weight of fresh soybean pods after removing the seeds was calculated per plant, carried out when the plants were harvested fresh at six weeks after planting (WAP). The number of seeds in the poll was counted for each plant and done when the plant was harvested.

**Data Analysis**

The data normality test analysis results showed that the data were not normally distributed; even after transformation data, it still showed the same thing. Thus, data analysis uses non-parametric analysis, namely Kruskall-Wallis's Analysis, to compare the two treatments. Meanwhile, comparisons between treatments used Wilcoxon analysis.

## RESULTS AND DISCUSSIONS

**Growth and Yield**

The height of the edamame plants at 2 WAP was highest in the control treatment with a value of 19.69 cm, followed by the *L. lecanii*, *B. bassiana*, and *M. anisopliae* treatments, with heights of 19.60, 19.11, and 18.65 cm (Table 2). Meanwhile, the Kruskall-Wallis's analysis showed no difference in the effect among pesticides (Sig= 0.761).

The height of the edamame plants at 4 WAP was highest in the control treatment with a value of 44.88 cm, followed by the *L. lecanii*, *B. bassiana*, and *M. anisopliae* treatments, with amounts of 44.80, 42.47, and 41.77 cm (Table 2). Meanwhile, the Kruskall-Wallis's Analysis results showed no difference in the effect of pesticide use (Sig= 0.238).

**Table 2. Plant height of Edamame Treated by Biopesticides.**

| Biopesticides | Plant heigh (cm) at 2 and 4 weeks after planting (WAP) | |
|---|---|---|
| | 2 | 4 |
| **No Biopesticide** | 19.69± 1,75 | 44.88±3.92 |
| **L. lecanni** | 19.60±2.26 | 44.80±3.36 |
| **B. bassiana** | 19.11±1.48 | 42.47± 4.19 |
| **M. anisopliae** | 18.65±2.01 | 41.77±3.13 |
| **Significance(ρ)*** | 0.761 | 0.238 |
| **Coeffisient of variance** | 1.91 | 3.72 |

Note: WAP= weeks after planting, *Kruskal-Wallis's Analysis

The observation results showed no differences at 2 WAP and 4 WAP. These results indicate that the effect of biopesticides did not directly affect plant height at 2 WAP and 4 WAP. Meanwhile, the type of pest that attacked edamame plants at the research location did not affect plant height during this growth phase. The results of other research showed that the average height of edamame plants in the



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lowlands at 2 and 3 WAP is 22.2 and 27.2 cm, respectively (Hakim, 2013), or the results of this study were lower than that research. These results indicated that other environmental factors also influenced plant height. In addition, Plant height is not directly affected by the control of pests, especially the use of pesticides. Pesticides only reduce pest populations' rates, so pesticides do not interfere with plant growth. In this research, it is suspected that pest populations, especially those that can disrupt growth (plant height), are not growing due to biological or biological pesticides.

The effect of pest disturbances also indirectly affected the number of productive branches. At 4 WAP observations, the highest was in the *L. lecanii* treatment, with a value of 4.89 branches per plant, followed by the Control, *M. anisopliae*, and *B. bassiana* treatments, with each branches of 4.69, 4.46, and 4.36 branches per plant (Table 3). Apart from that, the results of Kruskall-Wallis's Analysis showed that there was no difference in the effect of pesticides (Sig = 0.078).

The number of productive branches at 6 WAP was highest in the Control treatment with a value of 5.15 branches per plant, followed by the *L. lecanii*, *M. anisopliae*, and *B. bassiana* treatments, with each branches of 4.85, 4.76, and 4.43 branches per plant (Table 3). Meanwhile, the results of Kruskall-Wallis showed that there are differences in the influence of pesticides (Sig = 0.002). The results of the Wilcoxon analysis showed that the control treatment showed a difference between the *B. bassiana* (Sig = 0.34) and *M. ansiopliae* treatments (Sig < 0.05).

The number of productive branches at 8 WAP was highest in the control treatment with a value of 5.6 branches per plant, followed by the *M. anisopliae*, *L. lecani*i, and *B. bassiana* biopesticides, with each branches of 5.6, 5.5, and 5.5 branches per plant (Table 3). Then, the Kruskall-Wallis's test showed that there was no difference in the effect of pesticide use (Sig = 0.934).

**Table 3. Average of Branch Productive per Plant (Branch) of Edamame Treated by Biopesticides.**

| Biopesticides | Productive Branch at 4, 6, and 8 weeks after planting WAP | | |
|---|---|---|---|
| | 4 | 6 | 8 |
| **No Biopesticide** | 4.69±1,27 | 5.15 ±1,05 | 5.63 ±1,07 |
| **L. lecanni** | 4.89 ±1,41 | 4.85 ±0,91 | 5.50 ±1,06 |
| **B. bassiana** | 4.39 ±1,04 | 4.76 ±0,97 | 5.46 ±1,14 |
| **M. anisopliae** | 4.46 ±1,14 | 4.43 ±0,86 | 5.56 ±1,09 |
| **Significance(ρ)*** | 0.078 | 0.002 | 0.934 |
| **Coeffisient of variance** | 1.231 | 0.981 | 1.086 |

Note: WAP= weeks after planting; *Kruskal-Wallis's Analysis

The number of productive branches at 4, 6, and 8 WAP was also a parameter for Edamame growth. The research results also showed that using biopesticide on productive branches of Edamame at 4 WAP and 8 WAP had no effect. However, there was a difference in the effect of using biopesticide on productive branches at 6 WAP. It was suspected that growth influences productive branches in the number of leaves, while the pests that attack Edamame plants were a group of pests that destroy leaves. It can indirectly affect productive branches, especially at 6 WAP. The research also showed that productive branches reached 4.4 to 4.9 per plant. Meanwhile, Ramadhani et al., (2016) reported that the number of productive branches of edamame plants reached 3.53 to 4.40 branches per plant. The growth of plant branches is closely related to the development of plant height. So, there is no difference between pesticides in plant height parameters, followed by no difference in treatment of plant branch parameters.

The number of pods at harvest was highest in the Control treatment with a value of 18.9 g per plant, followed by the *L. lecanii*, *B. Bassiana*, and *M. anisopliae* treatments, with several pods of 18.1, 17.8, and 16.9% g per plant (Table 4). Then, the results of the Kruskall-Wallis's analysis showed no difference in the effect of pesticide use (Sig = 0.566). Furthermore, the highest average fresh seed weight in the Control treatment was 14.5 g per plant, followed by the *L. lecanni*, *B. bassiana*, and *M. anisopliae* treatments, with weights of 12.6, 12.3, and 11.5 g per plant (Table 4). Apart from that, the results of the analysis of variance showed that there was no difference in the effect of pesticide use (Sig= 0.133).



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**Table 4. Average Number of Pods (g/plant) and Weight of Fresh Seed (g/plant) .**

| Treatment | Number of pods harvest (g/plant) | Average weight of fresh seed (g/plant) |
|---|---|---|
| **No biopesticide** | 18.85±10,15 | 14.48 ±7,64 |
| **L. lecanni** | 18.09 ±8,64 | 12. 64±8,01 |
| **B. bassiana** | 17.79 ±9,84 | 12.27 ±8.14 |
| **M. anisopliae** | 16.85 ±8,71 | 11.52 ±6,72 |
| **Significance(ρ)*** | 0.566 | 7.674 |
| **Coeffisient of variance** | 8.897 | 0.133 |

Note: *Kruskal-Wallis's Analysis

The highest number of pods was in the control treatment at harvest time. However, there was no difference in the use of biopesticides. The number of pods was influenced by plant growth. So, the presence of pests that do not affect plant growth also does not affect the number of fruits. However, the number of pods planted in this study was lower compared to the research results of Susilo et al. (2022). Using 30 tons of manure per hectare, pods could reach 36 per plant on peat land. Furthermore, synthetic pesticides (control) and biopesticides were also thought to suppress pest populations on edamame plants. For example, biopesticide with the active ingredient *L. Lecanii* causes eggs from pests that attack edamame plants to infect fungi, causing the eggs to fail to hatch (Prayogo, 2009). Other reports that branching network and number of pods in plant populations. Combination several topological features that contribute to the overall number of pods on a plant. The reports show a branching network and a number of pods in plant populations (Dhakal et al., 2021). In addition, combining several topological features will contribute to the overall number of pods of plant pests in the field.

**Pests in Research Sites**

We were found types of pests on edamame plants planted in Tarakan City (at the research location) consisted of caterpillars and grasshoppers in the vegetation phase. Also, black ladybugs (pods-sucking) in the generative phase. (Table 5). These pests are generalist types of pests found on Tarakan Island. These locations are dominated by vegetable cultivation. Thus, the data showed pests potential on newly cultivated plants.

**Table 5. Pest of Growth Phase.**

| Pest | Growth Phase | | Symptom |
|---|---|---|---|
| | Vegetative | Generative | |
| **Grasshoppers** | +++ | + | Damage to plant leaves, especially at the edges and towards the center |
| **Caterpillars** | +++ | + | Damage to the leaves, especially in the middle |
| **Pod-sucking ladybugs** | - | +++ | Puncture marks on Edamame pods |

The results above showed that the effect of pests on edamame plants was damage to the leaves, especially those caused by armyworms and grasshoppers. Also, there was damage to the pods caused by pod-sucking ladybugs. Another research reported that armyworms (leaf-eating caterpillars) and grasshoppers are pests often found on edamame plants planted in the lowlands (Rohman & Haryadi, 2020). However, no other major pests were found in this study, for example, the whitefly (*B. tabaci*), and *R. linearis*. It is thought that the edamame plant was recently planted in Tarakan City, so disturbance from nuisance organisms or types of pests is still low compared to other areas. Then, there are only three types of pests due to the planting location being in an area that is not a center for soybean plants or plants from the legume family (Fabaceae family).



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The research results on plots used synthetic pesticide (control) that showed that damage at 2, 4, 6, and 8 weeks after planting (WAP) reached 26.16, 21.57, 16.89, and 19.67%, respectively. Observations on plots applied with *L. lecanni* biopesticide showed that damage at 2, 4, 6, and 8 weeks after planting (WAP) reached 19.86, 19.21, 18.95, and 18.59%, respectively. Furthermore, in plots where *B. bassiana* biopesticide was applied, it reached 21.86, 21.13, 21.86, and 22.41%, respectively. Meanwhile, in plots where *M. anisopliae* biopesticide was applied, the respective concentrations reached 21.75, 20.24, 21.94, and 20.34% (Table 5).

The Kruskall-Wallis's test analysis showed no difference in damage from leaf-destroying pests in plots using synthetic and biopesticide applications. Differences in leaf damage only occurred in 2 WAP (Sig= 0.019), which plots using synthetic pesticides compared to plots using biopesticides using *B. bassiana* and *M. anisopliae*. At the beginning of the observation of the effectiveness of pesticides, it appeared that synthetic pesticides caused the highest intensity of damage. It is suspected that existing pests, especially leaf destroyers, have become accustomed to or are not sensitive to these pesticides. Meanwhile, this type of biological pesticide is thought to cause a new aroma effect and is not liked by these pests.

**Table 6. Intensity of Pest Attack (%) of Leaf Damage 2, 4, 6, and 8 Weeks After Planting (WAP).**

| Treatment | 2 WAP | 4 WAP | 6 WAP | 8 WAP |
|---|---|---|---|---|
| **No Biopesticide** | 26.16$^{a}$±16,89 | 19.86 ±5,83 | 21.86 ±4,29 | 21.75 ±7,97 |
| **L. lecanni** | 21.57 $^{a}$±16,67 | 19.21 ±3,84 | 21.13 ±4,78 | 20.24 ±6,87 |
| **B. bassiana** | 16.89 $^{b}$±15,67 | 18.95 ±5,25 | 21.86 ±3,29 | 21.94 ±6,75 |
| **M. anisopliae** | 19.67 $^{b}$±14,86 | 18.95 ±4,61 | 22.41 ±3,37 | 20.34 ±5,45 |
| **Significance(ρ)*** | 0.019 | 0.874 | 0.246 | 0.521 |
| **Coeffisient of variance** | 16.29 | 4.93 | 4.01 | 6.811 |

Note: WAP= weeks after planting; *Kruskal-Wallis's Analysis ; Different letters on the column and the same observation time indicate no difference based on the Mann Whitney Test.

Damage to leaves at 2 WAP was lowest in the *B. bassiana* treatment and did not differ from other biopesticide treatments, except for the control treatment. It was thought that the population of leaf-destroying pests is still low, so the application of biopesticides can reduce the activity of these pests. According to Septian et al. (2021), at the beginning of application, biopesticides cause a decrease in insect appetite and reduced activity. In addition, these entomopathgenic has many hosts, including Lepidoptera, Hemiptera, Homoptera, and Coleoptera. Efficacy is around 99%, depending on the insect stage and pest order be controlled. Effectively controls the whitefly pest (*Bemisia tabaci*), which is very difficult to control with chemical insecticides. Toxic to *Aphis cracivora* and *A. glycine* pests, which are virus vectors. The entomopathogenic fungi *B. bassiana* are effective control of pod-sucking pests *Riptortus linearis*, *Nezara viridula*, and *Piezodorus hybne* (Prayogo, 2021).

The *M. anisopliae* biopesticide treatment also had the lowest damage at 4 WAP. Apart from that, there is no difference between using biopesticides and synthetic pesticides. It is suspected that biopesticides can control 4 MST leaf-destroying pests or be an alternative to synthetic controllers. The research results in laboratory conditions showed that the mortality of caterpillars was highest in *M. anisopliae*, followed by *B. bassiana*, and *L. lecanii* (Masyitah et al., 2017). *M. anisopliae* isolates have received the highest scientific attention in the genus and are the organisms most widely used in biological control (Zimmermann et al. 2007). Also, The Metarhizium genus is a microorganism that lives in soil and has been identified as being widespread worldwide. Species of this genus are facultative saprophytes and can live freely in the top layer of soil or sometimes act as parasites if the host is suitable or suitable (Kepler et al. 2014).

Based on this research, the use of biopesticides shows that leaf damage varies weekly. Biopesticide *M. anisopliae* had the lowest damage at 6 and 8 WAP, the lowest was in the *L. lecanni* treatment. Apart from that, there was no difference between biopesticide and synthetic pesticide treatments. However, leaf damage from *B. bassiana* biopesticide was higher than that caused by synthetic pesticide treatment. These results indicate that environmental factors can influence the effectiveness of biopesticides. Salaki


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& Peleal (2013) state that entomopathogenic fungi produce enzymes and toxins to kill their hosts. However, if there are inhibiting factors from either the host or the environment, this will reduce the ability of the entomopathogenic fungi.

The research showed that the lowest level of pod damage was in the Control treatment at 3.3%, followed by the *L. lecanii*, *M. anisopliae*, and *B. bassiana* treatments with damage of 9.8%, 9.7%, and 7.1%, respectively. Furthermore, the results of the analysis of Kruskall Wallis showed that there were differences in the influence of pesticide use (Sig = 0.01). The level of leaf damage using the *L. lecanii* pesticide treatment and other biopesticides was significantly different from the control treatment.

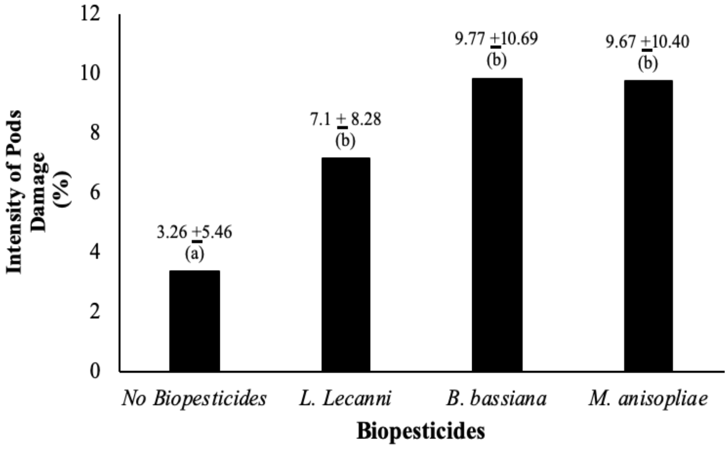


**Figure 1. Pod Damage Intensity (Note: Significance ($\rho$) value of Kruskall Wallis = 0.001; The Different Letters on the Bar Diagram and the Same Observation Time Indicate No Difference in Damage Intensity Based on the Mann-Whitney Test 5%)**

The lowest level of damage was in the control (no biopesticides) treatment. In this study, ladybugs also found that they sucked the pods, and the pest thought that this also affected pod damage. Biopesticides can control pests that attack pods, but their effectiveness is lower than that of synthetic pesticides. The results of research showed that the mortality of *R. linearis* or pod-sucking ladybirds was highest in the treatment of synthetic specifications containing the active ingredient Deltamethrin and was significantly different from Biopesticides made from other fungi, except for *Verticillum* sp there was no difference in the mortality of pod-sucking ladybugs (Prayoga 2005). In another research, biopesticides also reduce the number of empty pods, but their effectiveness is lower than that of synthetic pesticides. The number of pest pods influences the intensity of pest damage, among other factors. For example, in soybean varieties, microclimate factors, light intensity, temperature, and humidity influence plant height, number of leaves, number of filled pods, number of empty pods, and soybean production (Prayoga 2021; Gumilar et al., 2013).

## CONCLUSIONS

Plant pests on edamame soybean comprised leaf-eating pests (grasshoppers and lepidopteran larvae) and pod-sucking pests. The lowest level of leaf damage was at 2 WAP in the *B. bassiana* treatment. Furthermore, 4 and 6 MST on *M. Anisopliae*, and 8 MST on *L. lecanni* with damage of 16.69, 18.59, 20.88, and 20.24% respectively. There were differences in leaf damage in the no biopesticides and biopesticide treatments of *B. bassiana* and *M. anisopliae* at 2 WAP. Also, there was differences intensity pods damage among them. Generally, the effects of biopesticides were no different compared with synthetic pesticides, speesifically on growth and yield parameters. This indicates that biopesticides can be used as an alternative to pesticides in edamame farming.



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