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Effectiveness Test of Onion Peel Eco Enzyme as Bioinsecticide for Armyworm Pest (*Spodoptera litura*)

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ABSTRACT

Onion peels are organic waste, which could be a potential environmental pollutant without being appropriately managed. Onion peels were processed into more valuable materials through fermentation, an eco-enzyme. Onion peels eco enzyme is a bio-insecticide for insect pests such as armyworms (*Spodoptera litura*). This study aims to determine the effectiveness of eco enzyme from onion peel waste as a bio-insecticide against armyworms (*Spodoptera litura*). This research applied onion peels eco enzyme to the armyworms (*Spodoptera litura*) through spraying consisting of four treatments: Yasithrin 30 EC as control, 5 ml/L, E3 10 ml/L, and E4 30 ml/L. This study used an experimental method through a completely randomized design (CRD) pattern with four treatments and four replicates. Furthermore, the data was analyzed quantitatively by one-way analysis of variance (ANOVA). The results showed the highest deaths and the fastest death time when the eco enzyme was applied at 30 ml/L. The F test showed that the eco enzyme of onion peels significantly controls the armyworm (*Spodoptera litura*). Additionally, the BNT test (1%) showed no effect of different concentrations of eco enzyme of onion peels on the number and time of death of armyworms (*Spodoptera litura*). Moreover, the number of deaths and mortality time increased with the rise of onion peel eco enzyme concentration. This study showed that onion peel eco enzymes were effective as a bio-insecticide against armyworm (*Spodoptera litura*) pests within 82.5%-95% effectiveness level. Thus, it can be used as an eco-friendly retrieved pesticide.

Keywords: eco enzyme, organic waste, onion peel, bio-insecticide, pest, armyworm (*Spodoptera litura*)

1. INTRODUCTION

Household, agricultural, and industrial waste in the form of material remains from living creatures constitute an organic waste. Improper management of organic waste has the potential to contaminate the environment. Various methods are available to mitigate the pollution caused by organic waste, including converting organic waste into eco enzymes. Eco enzyme is produced through the fermentation of organic kitchen waste, such as fruit and vegetable pulp, combined with sugar and water (Rochyani et al., 2020). This mixture is left to ferment for three months. The eco-enzyme fermentation occurs under facultative anaerobic and aerobic conditions (Rijal *et al*., 2021).

Utilizing eco enzyme offers numerous advantages, primarily as a versatile cleaning solution. When mixed with water, eco enzyme liquid can serve as an effective floor cleaner, household furniture cleaner, and pesticide remover for fruits and vegetables. Additionally, the eco enzyme can enhance soil fertility, promote plant growth, eradicate pests, and enhance crops' overall quality and flavor.

According to Novianto's recent study (2022), eco-enzymes have been found to significantly enhance the growth and productivity of shallot plants (Allium ascalonicum . L). Moreover, eco-enzyme can be utilized as a repellent for household pests such as cockroaches, ants, flies, mosquitoes, and other insects, with recommended concentrations of 15 ml/L or 30 ml/L (Rizky, 2021). Istikomah's research (2022) demonstrates that a 2 ml/L eco-enzyme concentration effectively reduces the Bactrocera spp pests in shallot plants. This study specifically tested eco-enzyme efficacy against armyworm pests (Spodoptera litura).

Eco enzyme products are derived from natural sources and stand apart from conventional commercial cleaning solutions that often contain various chemical compounds like phosphates, nitrates, ammonia, chlorine, and other substances that pose a risk of environmental pollution. Organic waste, when left to decompose, emits methane gas (CH4), which contributes to the greenhouse effect by trapping heat and leading to a rise in temperature (Penmatsa et al., 2019).

By converting organic waste into eco enzymes, it is anticipated that significant strides can be made in mitigating the greenhouse effect and combating global warming.

Onion skins are typically discarded after the onion bulbs have been utilized, resulting in waste. These skins are often overlooked for their potential benefits. Onion skins, along with garlic skins, offer numerous advantages. Rich in antioxidants like flavonoids and quercetin, onion skins can aid in heart protection, combat aging, enhance the immune system, reduce cholesterol levels, prevent blood vessel blockages, and lower hypertension.

Red onion skins possess dietary fiber, which is beneficial for both the digestive system and skin health and aids in the treatment of insomnia (Pratama, 2019). These onion skins can be further utilized to create liquid fertilizer for plant nourishment due to their rich content of potassium (K), magnesium (Mg), phosphorus (P), and iron (Fe). Ethanol in onion skin extract (Banu, 2020) and garlic skin extract (Suwardi and Noer, 2020) exhibit antimicrobial properties, making it suitable as a natural pesticide. Alkaloids, flavonoids, saponins, tannins, and sulfur are compounds found in onion skin extract. These compounds serve as secondary metabolic compounds that act as repellents or feeding inhibitors, development inhibitors, egg-laying inhibitors, and rapid insecticides, thereby showcasing the potential of onion skin extract as a natural pesticide.

Natural pesticides consist of active components from plants, animals, and other organic substances. These

pesticides do not leave any detrimental residues on plants or the surrounding environment, and they can be produced using readily available ingredients found in the environment at a minimal expense. Insecticides, which impede the growth of insects, can be derived from natural ingredients or bioinsecticides, rendering them safer and more environmentally sustainable. The residues left behind by natural pesticides can be easily broken down by natural environmental processes, making them biodegradable and contributing to maintaining ecosystem equilibrium (Uge *et al*., 2021).

Bioinsecticides function in a highly targeted manner, similar to other natural pesticides. They exert their effects by impeding the growth of eggs, larvae, and pupae, hindering the molting process, disrupting insect communication, inducing feeding refusal in insects, inhibiting the reproduction of female insects, reducing appetite, blocking the insects' feeding ability, repelling insects, and impeding the development of disease-causing pathogens (Wahyuni et al., 2022).

Organic waste, such as onion peel, possesses the potential to serve as a natural pesticide. The extract derived from red onions exhibits mortality-inducing properties in termite populations and acts as a repellent against the Aedes aegypti mosquito (Yunira et al., 2022). The application of onion skin extract has demonstrated a mortality rate exceeding 50% in the population of armyworms (Spodoptera litura) (Sukmawati, 2022).

Armyworm, scientifically called Spodoptera litura, is a prevalent pest that attacks food and horticultural crops. The presence of these pests can hinder plant growth and decrease productivity. Insecticides are often utilized to combat these pests. Applying insecticides made from natural ingredients or bioinsecticides is considered environmentally friendly as they are biodegradable, facilitating easy decomposition in nature and preserving ecosystem balance (Uge *et al*., 2021).

The mitigation of the armyworm (Spodoptera litura) can be carried out using natural pesticides or bioinsecticides, one of which is an eco-enzyme derived from onion skin waste. The use of eco enzyme from onion skin as a bio-insecticide against the armyworm (Spodoptera litura) is yet to be explored. Therefore, it is necessary to conduct effectiveness tests of eco-enzymes from onion skin waste as a bio-insecticide against the armyworm (*Spodoptera litura*).

2. MATERIAL AND METHOD

A study testing the effectiveness of eco-enzyme from onion peels as a bio-insecticide against the tobacco cutworm (Spodoptera litura) was conducted from July to November 2023. The research occurred at the Biotechnology Laboratory, Faculty of Agriculture, Islamic University of Riau (0.44637, 101.45543).

The materials utilized included Yasithrin 30 EC as a control agent. The components that produce eco-enzymes are onion skins, brown sugar, and water. Third-instar armyworm (Spodoptera litura) larvae were employed as the test subjects in this investigation. Young corn leaves were provided to the test insects as their source of nourishment. The equipment comprises plastic bottle containers, scales, filters, sample boxes, transparent jar containers, knives, cutting boards, cloth filters, filter paper, hand gloves, sprayers, funnels, and measuring cups.

A sequence of research activities is delineated into various stages. The research stages adhere to the arrangement depicted in the flow chart (Figure 1).

The research process commences by formulating a research proposal, which includes identifying the problem, conducting a literature review, and preparing hypotheses. Subsequently, research tools and materials are prepared, such as creating eco-enzymes from onion skin waste and collecting

armyworms (Spodoptera litura) as test insects. Following this, the experimental phase ensues, involving data collection and analysis.

This research employs an experimental method utilizing a Completely Randomized Design (CRD) pattern to ensure a systematic approach. This design encompasses four treatments and four replications, suitable for the planned number of treatments.

Data analysis was carried out quantitatively, namely with one-way analysis of variance (ANOVA), to determine the effect of differences in onion peel eco enzymes on the death of armyworms (*Spodoptera litura*).

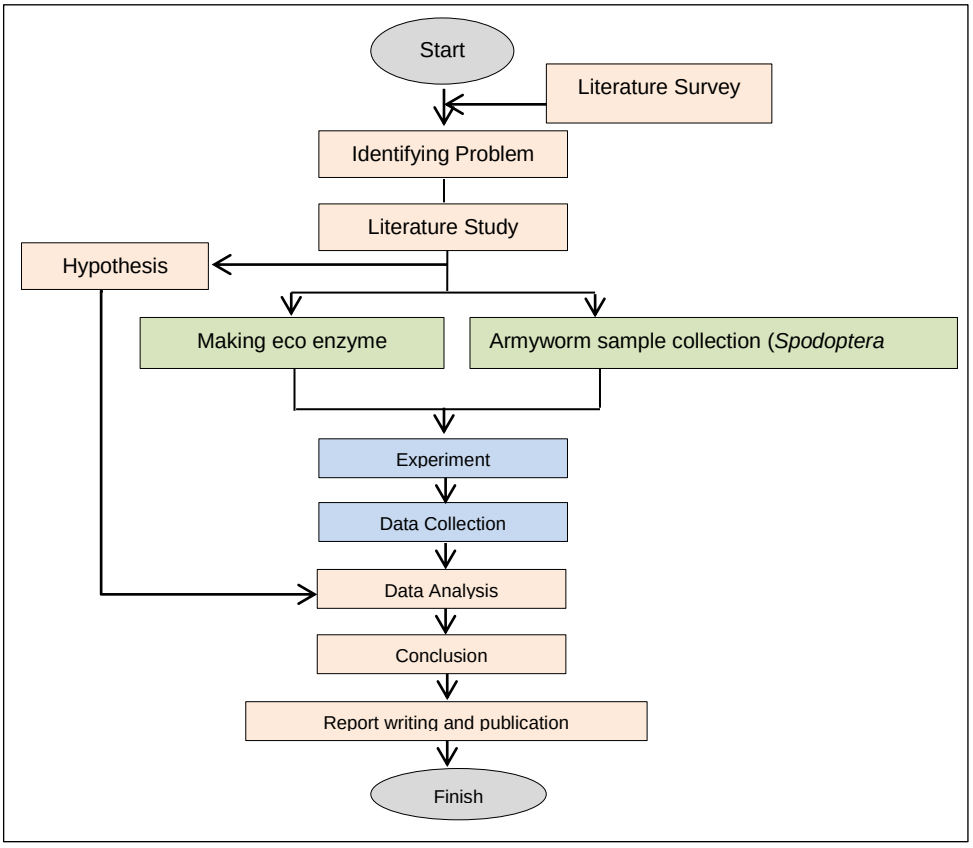

Figure 1. Flow chart of research stages

The study commenced by producing eco-enzymes initially. The components required for eco-enzyme production include water, waste, and sugar in a proportion of 10:3:1 (Galintin et al., 2021). To create eco enzyme from onion skins, 1 liter of water, 300 grams of onion skins, and 100 grams of palm sugar are utilized. Initially, the onion skins and sugar are crushed to achieve a finer consistency. Subsequently, the crushed onion skins and sugar are placed in a container, followed by the addition of water. The mixture is then stirred thoroughly until well combined and stored in a dry, cold location. The next step involves storing the mixture for three months. Initially, the container is opened daily for the first two weeks, every two or three days, and finally, once a week. After the three-month storage period, the eco-enzyme solution is ready for harvesting. The eco enzyme solution, or liquid, is obtained by filtering the mixture using gauze or a filter to separate it from the onion skin waste and sediment accumulating.

The application of treatment involves spraying. When pesticides are applied through spraying, they do not persist in the plant's tissues for an extended period. As a result, they are considered safer for consumption (Sekaringgalih et al., 2023). The spraying treatment included using Yasithrin 30 EC, a chemical insecticide liquid, as a control, and eco enzyme liquid at varying concentrations for each treatment. Before spraying, the armyworms (Spodoptera litura) were placed in jars, each containing 10 armyworms. Spraying was conducted every 10 minutes over 6 hours. This process was repeated four times for each treatment, resulting in 16 experimental samples. Subsequently, the number of pests that perished or became extinct after the treatment was counted, and the time of death for the fall armyworms (Spodoptera litura) was recorded.

The level of effectiveness of onion skin eco enzyme as a bio-insecticide against armyworm pests (Spodoptera litura) follows the Decree of the Minister of Agriculture of the Republic of Indonesia Number 369/KPTS/SR.330/M/6/2020 with efficacy criteria for insecticides ≥ 70% (Kementeri Pertanian Republik Indonesia, 2020).

3. RESULT AND DISCUSSION

Table 1 presents the findings from the experimentation conducted to assess the efficacy of the onion peel eco enzyme as a bio-insecticide against armyworm pests (Spodoptera litura). The results indicate that certain armyworms (Spodoptera litura) have perished or gone extinct.

Table 1 . Data on the number of deaths of armyworms (Spodoptera litura) against various concentrations of onion skin eco enzyme

Treatment	Total Deaths				Quantity (MA)	Mean ($\bar{y}\mathbf{A}$)
	M1	M2	M3	M4		%
E1 (Control)	10	10	10	10	40	100
E2 (5 ml/L)	8	9	8	8	33	82.5
E3 (15 ml/L)	9	8	9	9	35	87.5
E4 (30 ml/L)	10	10	8	10	38	95

Based on the information presented in Table 1, it is evident that different concentrations of onion skin eco enzyme have led to the mortality of armyworms (Spodoptera litura). The data indicates that as the concentration of the onion peel eco enzyme solution increases, the number of armyworms (Spodoptera litura) that perish also rises. Specifically, the highest mortality rate was observed in treatment E4, where 30 ml/L of onion peel eco enzyme solution was sprayed. Conversely, the lowest mortality rate of armyworms (Spodoptera litura) was recorded in treatment E2, involving the application of onion peel eco enzyme with a concentration of 5 ml/L.

Onion skin contains compounds like acetogenin, squamosin, flavonoids, polyphenols, saponins, terpenoids, and alkaloids. These compounds are crucial in pest management, particularly in controlling armyworms (Spodoptera litura). Acetogenin, for instance, exhibits stomach toxicity at low levels and acts as an anti-feeder at higher concentrations. On the other hand, squamosin compounds can interfere with electron transfer, disrupting insect respiration (Damanik *et al*., 2022).

Various compounds found in organic waste, specifically onion skins and garlic skins, have the potential to serve as organic pesticides, offering an alternative to chemical pesticides (Sumargono et al.,

2022). The creation of onion skin powder has proven successful in repelling mosquito larvae (Culex sp) (Rahmayanti et al., 2022). Furthermore, research indicates that onion skin extract can effectively inhibit mosquito larvae growth (Anopheles Stephensi) (Babu and Ashok, 2021). This result suggests that utilizing onion skins as a natural insecticide could present a promising new approach to controlling insect pests like armyworms (Spodoptera litura).

Natural insecticides are regarded as more ecologically friendly than those derived from synthetic chemical compounds, which farmers commonly utilize. Chemical pesticides typically contain compounds such as Dichloro-Dyphenil-TrichloroEthane (DDT), endrin, carbofuran, and tamorin, which can leave behind residues that have the potential to contaminate the environment. In addition to their detrimental environmental effects, chemical insecticides can lead to pest resistance. As a result, farmers often use these chemical insecticides extensively and frequently, exacerbating the negative impacts on the environment in terms of living organisms and non-living factors. This excessive use can result in resistance symptoms, the destruction of natural predators, pest resurgence, and the disruption of the health of those who handle these chemicals.

The efficacy of onion skins as a natural insecticide has been investigated and proven effective. Using onion skins as a bio insecticide or natural insecticide can be achieved by employing eco enzymes. Previous studies have successfully demonstrated the production of eco enzymes from onion skin waste. The outcome of this process is a dark brown liquid with a distinct sour scent. Maryanti and Wulandari (2023) conducted a study on the production of the eco-enzyme from onion skin waste, which resulted in a liquid volume comprising 98% of a dark brown color and a sour aroma.

The efficacy of onion skin eco enzyme as a bio-insecticide against armyworm pests (Spodoptera litura) was investigated in a research study. The liquid form of onion skin eco enzyme was applied to the armyworm pests (Spodoptera litura) to assess its impact. The application of onion peel eco enzyme resulted in the mortality of armyworm pests (Spodoptera litura).

A spraying procedure was conducted in four repetitions to evaluate the effectiveness of the treatment. The data obtained from this experiment was represented in a graph illustrating the number of armyworm (Spodoptera litura) deaths over 360 minutes (Figure 2). It was observed that the highest number of armyworm (Spodoptera litura) deaths occurred in the eco enzyme treatment with a concentration of 30 ml/L in the first, second, and fourth repetitions. However, in the third repetition, only eight fall armyworms (Spodoptera litura) succumbed to the treatment. Interestingly, the lowest number of armyworm (Spodoptera litura) deaths was recorded in treatment E2, which involved an eco enzyme concentration of 5 ml/L. This treatment resulted in an average of eight armyworms (Spodoptera litura) fatalities.

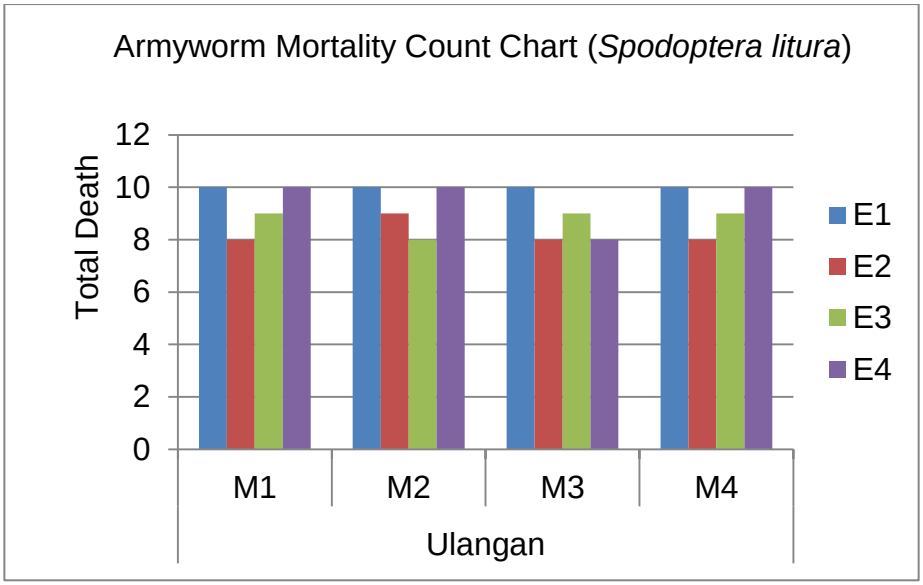

Figure 2. Armyworm Mortality Count Chart (*Spodoptera litura*)

According to the data presented in the graph, it is evident that the control treatment, specifically the application of Yasithrin 30 EC, resulted in the highest number of armyworm (Spodoptera litura) deaths. The repeated spraying of Yasithrin 30 EC led to the mortality of all armyworm test insects in each trial. This outcome can be attributed to the active compound, supermethrin 30 g/L, present in Yasithrin 30 EC. Supermethrin is a concentrated substance that can be emulsified into a toxic solution, proving highly lethal to various pests, including armyworms (Spodoptera litura), fruit flies, cropworms, and similar nuisances (Mantzos *et al*., 2016).

The concentration of onion peel eco enzyme has been observed to directly impact the mortality rate of fall armyworms (Spodoptera litura), as indicated by a significant decline in their numbers. Onion skins contain various repellent compounds, including flavonoids, polyphenols, saponins, terpenoids, alkaloids, essential oils, and saponin enzymes. These compounds possess characteristics such as a bitter taste, foul smell, and slight spiciness. Their repellent properties deter insects, preventing them from being killed rapidly.

In a study conducted by Budiyanto (2016), it was discovered that the death percentage of armyworms ranged from 82.5% to 100%. The control treatment, which involved spraying Yasithrin 30 EC, resulted in a 100% mortality rate. On the other hand, applying onion skin eco enzyme as a bioinsecticide demonstrated effectiveness ranging from 82.5% to 95% in controlling armyworm pests (*Spodoptera litura*) (Table 2).

Table 2. Average Percentage of the effectiveness of eco enzyme as bioinsecticide on the number of deaths of armyworms (Spodoptera litura)

Treatment	Mean (%)
E1 (Control)	100*±0c
E2 (5 ml/L)	82,5*±0.25a
E3 (15 ml/L)	87,5*±0.25ab
E4 (30 ml/L)	95*±0.5bc

Note: Numbers followed by the same letter are not significantly different at the 1% test level.
*=Effective

Table 2 illustrates that the Yasithrin 30 EC spraying treatment had the highest fatality rate. Yasithrin 30 EC is a yellow concentrate insecticide that functions as both a contact poison and a stomach poison, capable of being emulsified for plant pest control. Yasithrin 30 EC does not compromise the plant's flavor despite its potency. The primary active component found in Yasithrin 30 EC is cypermethrin, a compound known for its limited solubility in water and its efficacy in targeting the digestive systems of insects. Due to its effectiveness and affordability, cypermethrin is commonly employed in insect pest management strategies (Mantzos *et al*., 2016).

The research findings indicated that applying eco enzyme spraying treatment resulted in a death percentage of armyworms (Spodoptera litura) ranging from 82.5% to 95%. This result demonstrates the effectiveness of the onion peel eco enzyme as an insecticide, with an efficacy level of at least 70%. Furthermore, Mulyati's 2020 research also confirmed the efficacy of onion peel as a natural pesticide for controlling the tri-tip caterpillar pest (Plutella xylostella) on green mustard greens.

To further analyze the obtained research results, an analysis of variance was conducted using a Completely Randomized Design (CRD) pattern. The variance analysis data revealed that the calculated F value was greater than the tabulated F value, precisely 6.44 > 5.95. This result indicates that applying the onion peel eco-enzyme has significant influences on the mortality rate of armyworm pests (Spodoptera litura).

Moreover, the diversity coefficient (KK) obtained in this study was 6.71, which falls within the low category (<10%). Subsequently, additional tests were conducted using the BNT Test (Least Significant Difference) at a significance level of 1% to determine the variations in the effects of each treatment. The results of the BNT test can be found in Table 3 below.

Table 3. Smallest Significant Difference Test (BNT) on the effectiveness of onion skin eco enzyme as a bioinsecticide for armyworms (Spodoptera litura)

Treatment	Mean+BNT
E1	10.90±0c
E2	9.15±0.01a
E3	9.65±0.01ab
E4	10.40±0.01bc

Note: Numbers followed by the same letter are not significantly different at the 1% test level

Based on the data presented in Table 3, it is evident that there is no significant difference between the treatment values of E2 and E3. Similarly, the comparison between the treatment of E3 and E4 also shows no significant difference. This result indicates that the application of onion peel eco enzyme at varying concentrations of 5 ml/L, 15 ml/L, and 30 ml/L did not have a notable impact on the mortality of armyworms (Spodoptera litura). In contrast, eco enzyme treatment significantly differed from the treatment involving Yasithrin 30 EC. This result suggests that the application of Yasithrin 30 EC substantially affects the mortality of armyworms (Spodoptera litura).

According to the findings of Batubara et al. (2021), their research also indicated that the concentration variations of organic pesticides derived from ketapang leaf extract did not have any impact on the mortality rate and stopping ability of armyworm larvae (Spodoptera litura). This lack of effect can be attributed to the larvae's inability to detect changes in food based on the alterations

in odor caused by the compounds present in each treatment concentration.

Upon analyzing the variance data, it is evident that the utilization of the onion peel eco enzyme does not exhibit a significant difference compared to the control group in terms of the average rate of mortality among armyworm pests (*Spodoptera litura*). The average speed of death for these armyworms can be observed in Table 4.

Table 4. Average time rate of death of armyworms (Spodoptera litura) after spraying onion skin eco enzyme.

Treatment	Average Speed Time of Death (minutes)
E1	125.5±0.07a
E4	128.8±0.09ab
E3	135.6±0.08abc
E2	163.4±0.08cd

The control treatment with Yasithrin 30 EC spraying resulted in the fastest average death rate for armyworms (Spodoptera litura) at 125.5 minutes. The research findings indicated that the death time for armyworm pests (Spodoptera litura) was accelerated with higher concentrations of onion skin eco-enzyme (Figure 3). Nevertheless, applying Yasithrin 30 EC led to a quicker demise of armyworm pests than using an onion skin eco enzyme. Onion peel eco enzyme, functioning as a vegetable insecticide or bioinsecticide, exhibits a relatively slow reaction or efficacy compared to chemical pesticides. Generally, botanical pesticides render pests more vulnerable to sunlight exposure, making their bodies more susceptible to damage. Botanical pesticides' drawback is their relatively slow action, resulting in delayed observable effects. Furthermore, natural pesticides typically do not induce direct mortality in target pests but act as repellents, discouraging pests from approaching cultivated plants (Saenong, 2017).

A b c d e

Figure 3. Time of death of armyworms (Spodoptera litura); a = before treatment, b = treatment E1, c = treatment E2, d = treatment E3, e = treatment E4

4. CONCLUSION

According to the findings of the conducted research, it is evident that the mortality rate of fall armyworms (Spodoptera litura) decreases as the concentration of onion peel eco enzyme decreases. Moreover, the time taken for fall armyworms (*Spodoptera litura*) to perish increases with the concentration of onion peel eco enzyme. The results of the F test indicate a highly significant impact of the onion peel eco enzyme in managing armyworm pests (Spodoptera litura). In contrast, the BNT test (1%)

reveals no significant impact of varying concentrations of onion peel eco enzyme on the mortality rate and time of death of armyworms (Spodoptera litura). Onion peel eco enzyme demonstrates efficacy as a bio-insecticide against armyworm pests (Spodoptera litura), with effectiveness ranging from 82.5% to 95%.

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REFERENCE

Babu, M., & Ashok, K. (2021). Larvicidal Activity of Onion (Allium cepa) Peel Extracts Against Anopheles Stephensi. *International Journal of Zoological Investigations*, *7*(2), 600–602. https://doi.org/10.33745/ijzi.2021.v07i02.042

Banu, L. S. (2020). Review: Pemanfaatan Limbah Kulit Bawang Merah dan Ampas Kelapa sebagai Pupuk Organik terhadap Pertumbuhan Beberapa Tanaman Sayuran. *Jurnal Ilmiah Respati*, *11*(2), 148–155. https://doi.org/10.52643/jir.v11i2.1125

Batubara, R. S., & Mahmud, Yusmar, R. E. (2021). Test effectiveness of some ketapang leaf extract concentration (*Terminalia catappa* L.) to grayak caterpillars (*Spodoptera litura*). *Jurnal Dinamika Pertanian Edisi XXXVII Nomor*, *1*(April), 23–28. https://doi.org/10.37676/jnph.v8i2.1190

Budiyanto, M. A. K. (2016). *Cara Membuat Insektisida Organik*. Universitas Muhammdiyah Malang Press.

Damanik, D. L., Novianti, S., Ifana, C. A., & Firmansyah, L. (2022). Pestisida nabati berbahan baku limbah kulit bawang merah *(Allium cepa* L *.)* untuk mengatasi hama penting pada tanaman asparagus *(Asparagus officinalis). Jurnal Pusat Inovasi Masyarakat*. *4*(2), 151–158. https://journal.ipb.ac.id/index.php/pim/article/view/43276/24434

Galintin, O., Rasit, N., & Hamzah, S. (2021). Production and characterization of eco enzyme produced from fruit and vegetable wastes and its influence on the aquaculture sludge. *Biointerface Research in Applied Chemistry*, *11*(3), 10205–10214. https://doi.org/10.33263/BRIAC113.10205102 14

Istikomah, D. (2022). Pengaruh konsentrasi eco-enzyme dan frekuensi fertigasi tetes terhadap populasi hama dan musuh alami tanaman bawang merah *(Allium ascalonicum)*. http://eprints.upnyk.ac.id/id/eprint/31152

Kementeri Pertanian Republik Indonesia. (2020). *Keputusan Menteri Pertanian Nomor 369/KPTS/SR.330/M/6/2020* (pp. 1–15). Kemterian Pertanian Republik Indonesia. https://simpel1.pertanian.go.id/api/dokumen/regulasi/dokumen-1592965366044.pdf

Mantzos, N., Karakitsou, A., Hela, D., & Konstantinou, I. (2016). Environmental fate of the insecticide cypermethrin applied as microgranular and emulsifiable concentrate formulations in sunflower cultivated field plots. *Science of the Total Environment*, *541*, 542–550. https://doi.org/10.1016/j.scitotenv.2015.09.117

Maryanti, A., & Wulandari, F. (2023). Jurnal Biologi Tropis Production and Organoleptic Test of Onion Peel Eco enzyme. *Jurnal Biologi Tropis*, *23*(2),

311 – 318. https://doi.org/10.29303/jbt.v23i2.4708

Mulyati, S. (2020). efektivitas pestisida alami kulit bawang merah terhadap pengendalian hama ulat tritip (*Plutella Xylostella*) pada tanaman sayur sawi hijau. *Journal of Nursing and Public Health*, *8*(2), 79–86. https://doi.org/10.37676/jnph.v8i2.1190

Novianto, N. (2022). Response of liquid organic fertilizer eco enzyme (EE) on growth and production of shallot (*Allium Ascalonicum*. L). *Jurnal Agronomi Tanaman Tropika (Juatika)*, *4*(1), 147–154. https://doi.org/10.36378/juatika.v4i1.1782

Penmatsa, B., Sekhar, D. C., Diwakar, B. S., & Nagalakshmi, T. V. (2019). Effect of bio-enzyme in the treatment of fresh water bodies. *International Journal of Recent Technology and Engineering*, *8*(1), 308–310. https://www.researchgate.net/publication/334162480_Effect_of_Bio-Enzyme_in_the_Treatment_of_Fresh_Water_Bodies

Pratama, R. (2019). Efek Rumah Kaca Terhadap Bumi. *Buletin Utama Teknik*, *14*(2), 1410–4520. https://jurnal.uisu.ac.id/index.php/but/article/view/1096/852

Rahmayanti, R., Hadijah, S., & Fitriana, F. (2022). Potential testing of waste skin onion (*Allium ascalonicum*) as a larvacide against the death of mosquito larvas *Culex* sp. *Biotik: Jurnal Ilmiah Biologi Teknologi Dan Kependidikan*, *10*(2), 138. https://doi.org/10.22373/biotik.v10i2.13460

Rijal, M., Surati, Amir, I., Abdollah, A., Lessy, abu bakar, Ytatroman, abd sofyan, & Tanama, A. (2021). Eco-enzyme dari limbah tanaman maluku. [Diakses pada 15 Maret 2024]. http://repository.iainambon.ac.id/2308/1/BUKU ECO-ENZYME.pdf

Rizky. (2021). *Mengenal Eco Enzyme, Cairan Organik yang Punya Banyak Manfaat*. [Diakses pada 22 April 2024] https://www.orami.co.id/magazine/eco-enzyme

Rochyani, N.-, Utpalasari, R. L., & Dahliana, I. (2020). Analisis hasil konversi eco enzyme menggunakan nenas (*Ananas comosus*) dan pepaya (*Carica papaya* L.). *Jurnal Redoks*, *5*(2), 135. https://doi.org/10.31851/redoks.v5i2.5060

Saenong, M. S. (2017). Tumbuhan Indonesia potensial sebagai insektisida nabati untuk mengendalikan hama kumbang bubuk jagung (*Sitophilus* spp.). *Jurnal Penelitian Dan Pengembangan Pertanian*, *35*(3), 131-142. https://doi.org/10.121082/jp3.v35n3.2016.p131-142

Sekaringgalih, R., Rachmah, A. N. L., Susanti, Y., A'yun, A. Q., & Ansori, A. (2023). Edukasi pembuatan pestisida nabati dari kulit bawang merah di desa Bagorejo Kabupaten Banyuwangi. *Jurnal Pengabdian Pada Masyarakat*, *8*(2), 318–327. https://doi.org/10.30653/jppm.v8i2.335

Sukmawati. (2022). *Efektivitas ekstrak metanol kulit bawang merah (Allium cepa L .) dan kulit bawang putih (Allium sativum L .) dalam pengendalian ulat grayak jagung (Spodoptera frugiperda)* (J. E. Smith) (Lepidoptera: Noctuidae). [Diakses pada 20 April 2024]. http://repository.unhas.ac.id/id/eprint/25786/

Sumargono, Tarkono, Perdana, Y., Sihombing4, H. L. H., Fakhza, M. F., Wahyudi, R., Setiawan, Y., Permatasari, I., Rahmawati, K., Lisana, & 'Aliya, S. (2022). Pestisida organik sebagai alternatif pestisida kimia melalui pemanfaatan limbah kulit bawang merah dan bawang

putih. *Jurnal Pengabdian Kepada Masyarakat Buguh*, *2*(3), 16–23. https://doi.org/https://doi.org/10.23960/buguh.v2n3.1116

Suwardi, F., & Noer, S. (2020). Uji aktivitas antioksidan ekstrak etanol kulit bawang merah (*Allium ascalonicum* L .). *Sinasis*, *1*(1), 117-120. https://proceeding.unindra.ac.id/index.php/sinasis/article/view/4018/622

Uge, E., Yusnawan, E., & Baliadi, Y. (2021). Pengendalian ramah lingkungan hama ulat grayak (*Spodoptera litura* Fabricius) pada tanaman kedelai. *Buletin Palawija*, *19*(1), 64–80. https://doi.org/https://dx.doi.org/10.21082/bulpa.v19n1.2021.p64-80

Wahyuni, D., Sari, N. P., Jasril, & Syahri, J. (2022). Bio-insecticide's extract of scented root (*Polygala paniculata*) in controlling the mosquito (*Aedes aegypti* .L.). *Makara Journal of Science*, *26*(2), 107–113. https://doi.org/10.7454/mss.v26i2.1303

Yunira, E., Tutik., Marcellia, S. (2022). Uji efikasi repelan terhadap nyamuk *Aedes aegypti* sediaan losio ekstrak metanol kulit bawang merah (*Allium cepa* L.) dengan metode ekstraksi sokletasi dan refluks. *Jurnal Sains Dan Teknologi Farmasi Indonesia*, *XI*(2), 115–126. http://dx.doi.org/10.58327/jstfi.v11i2.198