E-ISSN-2580-7129
Print- ISSN-1978-6107

TECHNO: JURNAL PENELITIAN
Journal homepage: http://ejournal.unkhair.ac.id/index.php/Techno
Volume 11 Number 01 May 2022 DOI: http://dx.doi.org/10.33387/tjp.v11i1.3315

Effects of Nuclear Polyhedrosis Virus (NPV) on The Death of *Spodoptera litura* Larvae (Lepidoptera: Noctuidae) and its Comparison with Chemical Pesticide

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Received : 19-07-2021
Accepted : 03-04-2022
Available online : 30-05-2022

ABSTRACT

Spodoptera litura larvae are polyphagous insects and have caused a lot of damage to various commodities. The application of *Nuclear Polyhedrosis Virus* (NPV) can be used as an alternative to control, other than by using chemical pesticides. This research was conducted to compare the mortality of *S. litura* with NPV treatment and compare them with chemical pesticides. NPV treatment with a concentration of 0.3% is used to soak the leaves to be used as larvae feed, as well as chemical pesticides the active ingredient Lambda-cyhalothrin (with a concentration of 0.05%). Observations were made at 2, 24, 48, and 76 hours after application. The parameters observed from the treatment included the percentage of mortality and morphological changes of larvae. Observation of the morphological changes of larvae was carried out by the parameters of slowing motion, discoloration, decaying, and severe shrinkage. Based on the results of the comparison, the percentage of mortality in the treatment of chemical pesticides is higher than the NPV. Death of 100% in Lambda-Cyhalothrin treatment was recorded in the first 2 (two) hours, while for NPV treatment is as much as 80%. The larvae with NPV treatment undergo a process of color change and the decomposition process is faster than the treatment of Lambda-cyhalothrin.

Keywords: Lambda-Chyhalothrin, Mortality, *Nuclear polyhedrosis virus*, *Spodoptera litura*

ABSTRAK

Larva *Spodoptera litura* merupakan serangga polifag dan banyak menimbulkan kerusakan pada berbagai komoditas. Penerapan *Nuclear Polyhedrosis Virus* (NPV) dapat dijadikan alternatif pengendalian selain dengan menggunakan pestisida kimia. Penelitian ini dilakukan untuk membandingkan mortalitas *S. litura* dengan perlakuan NPV dan membandingkannya dengan pestisida kimia. Perlakuan NPV dengan konsentrasi 0,3% digunakan untuk merendam daun untuk dijadikan pakan larva, serta pestisida kimia dengan bahan aktif Lambda cyhalothrin (dengan konsentrasi 0,05%). Pengamatan dilakukan pada 2, 24, 48 dan 76 jam setelah aplikasi. Parameter yang diamati dari perlakuan meliputi persentase kematian dan perubahan morfologi larva. Pengamatan perubahan morfologi larva dilakukan dengan parameter gerak lambat, perubahan warna, pembusukan, dan penyusutan berat. Berdasarkan hasil perbandingan, persentase kematian pada perlakuan pestisida kimia lebih tinggi dibandingkan dengan NPV. Kematian 100% pada perlakuan Lambda-Cyhalothrin tercatat pada 2 (dua) jam pertama, sedangkan untuk perlakuan NPV sebanyak 80%. Larva dengan perlakuan NPV mengalami proses perubahan warna dan proses dekomposisi yang lebih cepat dibandingkan dengan perlakuan Lambda cyhalothrin.

Kata kunci: Lambda-Chyhalothrin, Mortalitas, *Nuclear polyhedrosis virus*, *Spodoptera litura*

INTRODUCTION

Spodoptera litura (Lepidoptera: Noctuidae), better known as armyworm (Bahasa: Ulat Grayak) is one of the most damaging pests on plants. *S. litura* becomes a pest in tobacco (Batubara et al., 2017), oil palm plantations, and attacks Palmae and legume plants in general, but has a strong preference for soybeans (Tengkano et al., 2005). *S. litura* lives in a broad range of hosts as polyphagous pest, and causes serious damage. Through pheromone trap studies, it can be seen that the outbreak of *S. litura* begins during the rainy season in september and october, when temperatures and sunshine hours increase (Ramesh et al., 2015).

Various active ingredients of pesticides are used to control the attack, and provide low to moderate (indoxacarb, abamectin, fipronil, and methoxyfenozide), low (spinosad), and not/very low (emamectin benzoate, chlorfenapyr, and lufenuron) resistance effects (Ahmad & Mehmood, 2015). In addition, it is also noted that the use of natural pesticides to control *S. litura* populations, such as Mindi (*Melia azedarach*) extract, and Seed Oil (*Azadirachta indica*) (Ramadhan et al., 2016).

The use of biological controls agent aims to control and maintain the population of pests below the economic level. Steinernematid and Heterorhaditid nematodes are used to overcome *S. litura* attacks on Chinese cabbage (Kim et al., 2008). Entomopathogenic fungi, such as conidia, *M. anispliae*, Fumororosea 32, and *B. bassiana* 25 are tested on a laboratory scale to infect eggs and larvae of *S. litura* (Asi et al., 2013; Ullah et al., 2019). In addition, entomopathogenic rhizobacteria are known to cause necrotic reactions, and also tested with positive results for controlling *S. litura* (Nelly et al., 2020).

One of the most potential is Nuclear Polyhedrosis Virus (NPV), which is a deadly virus with pathogenic characterstics to *S. litura* (Maqsood et al., 2017). However, the challenges of using NPV as a biological control in Indonesia encountered various problems. Its effectiveness depends greatly on various types of commodities and the environment, and this is compared to chemical pesticides as its competitors in the field. In addition, NPV is one of the best choices without disturbing ecological function after its application. This journal aims to compare the death process observed in *S. litura* after NPV application and compare it with chemical insecticides.

METHODOLOGY

This research was conducted at the Agrotechnology laboratory, Faculty of Agriculture, Jember University. For biological control tests, NPV isolates were weighed and dissolved with distilled water to 0.3% concentration. Ten *Jatropha* sp. leaves are soaked in NPV solution for 30 seconds, then dried on a tray. The leaves that had been coated with NPV isolates were placed in jars with aeration containing 10 larvae of *S. litura*. For chemical pesticides treatment, we used contact pesticides with Lambda-cyhalothrin the active ingredient. The pesticide is dissolved with distilled water to become 0.05% concentration, and sprayed on 10 *Jatropha* sp. leaves. Ten larvae of *S. litura* were placed in an aerated jar filled with leaves. Both of these concentration comparisons are based on the recommendations of each brand.

We provide control for all treatments. Observations were made at 2, 24, 48, and 76 hours with the parameters observed including mortality and morphological changes after treatment. Observation of the movement of larvae aimed to determine the reaction of larvae after eating leaves that have been treated with pesticides. We determined the parameters of morphological changes in death to slowing motion, discoloration, decay, and drying as shown in table 1.

Table 1. Parameters of morphological changes

Parameters	Description
Slowing motion	Decreased intensity of feeding, and mobility, until is stable for more than 10 minutes.
Discoloration	Color changes occur in more than 50% of the body.
Decaying	The emergence of fluids from the body due to the decomposition process, the appearance of a sharp odor, and the carcass getting softer.
Drying	The carcasses are shrinking to around 30-50% of normal size

RESULTS AND DISCUSSION

The Comparison of *Spodoptera litura* Mortality in NPV Isolates, and Chemical Insecticides

The results of observations related to the mortality ratio of S. litura on NPV isolates and chemical insecticides are shown in table 2.

Table 2. Comparison of *S. litura* mortality in NPV isolates, and chemical insecticides

		Mortality (%)	
		2 hours	**24 hours**
NPV	control	0	0
	0,3%	80	100
chemical insecticides	control	0	0
	0,05%	100	100

Based the data in table 2, at 2 hours of observation, there are 80% of *S. litura* with NPV treatment had stopped moving and 20% had begun to move slowly, and there were observed color changes in the carcass as shown on figure 1 and figure 2. At 24 hours, all larvae have died and more carcasses undergoing discoloration as shown on figure 3.

Figure 1. Observation results of treatments on NPV. (A) surface of jatropha leaves that have been soaked by NPV solution, (B) slowing motion and death observed at 2 hours, (C) changing color to dark brown, (D) dry carcass.

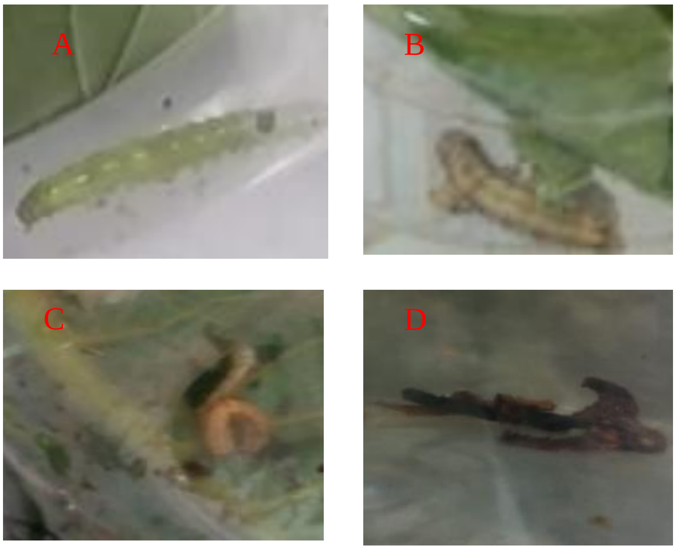

Figure 2. Observation results of treatments on the chemical insecticides;
(A) slowing motion and death observed at 2 hours, (B) and
(C) changes in color to red-brown and dark brown, (D) dry carcass

In comparison, the chemical insecticide treatment showed 100% of deaths in the first 2 hours (figure 2). This shows higher toxic effectiveness than NPV. Next, at 24 hours of observation, no morphological changes in the carcass were observed. However, within 48 hours of observation, 30% of carcasses have a reddish brown color (figure 2). At 76 hours, observations showed 40% discoloration, and there had been decay on 100% of carcasses (figure 2). This is not the same as the result of NPV treatment, where drying and decaying due to pesticides occur more slowly.

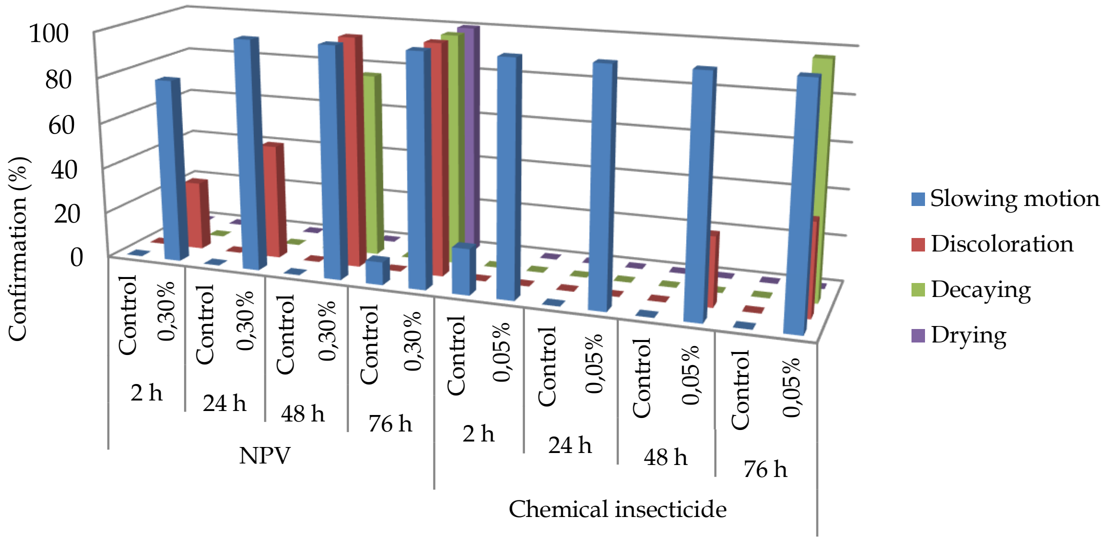

Figure 3. Comparison of morphological changes after NPV
and chemical insecticide treatment

Based the graphic in figure 3, there are 50% of carcasses have discoloration. Then, decomposition occurred in 80% of carcasses in 76 hours. The NPV treatment caused complete decay at 76 hours, and many small insects were observed visiting the carcass.

NPV that is ingested with food will multiply in the nucleus through the digestive system. Then, NPV infects other body tissues. NPV can start to replicating an hour after infection. The infected nucleus will swell eight hours after infection (Diyasti et al., 2016). The first symptom of NPV infection in *S. litura* can be observed in the motion system. The larvae are agile and move actively, then become slow and stop eating. This is in line with (Zulfahmi et al., 2015), where NPV infected larvae will experience abnormal symptoms morphologically, physiologically, and their behavior. In the initial stages marked by decreased appetite, slow movements, swollen body, and the color of the body become yellow and if touched will emit a thick liquid that contains virus particles. In the next stage, the larvae will die due to the cessation of metabolism and damage to body tissue.

Viral replication that occurs is influenced by several factors, including dosage, larval age, temperature, and larval species (Bedjo, 2004). The high concentration of NPV affects the rapid replication of the virus (Rimadhani et al., 2013). The sensitivity of larvae to infections decreases with body development, age, and weight (Sanjaya et al., 2010). That is because the vulnerable organs are more easily infected, especially intestinal organs as the main target of NPV.

Based on observations, there is a change in color on the carcass to brownish red, then the body position of the larvae forms the letter 'V'. This is following the research of (Rimadhani et al., 2013), where infected larvae crawled to the top of the plant and died in a dangling position. Furthermore, decay occurs within 24-48 hours. The carcass will emit a very pungent odor, which comes from the larval body tissue (Bedjo, 2004). NPV also decreases feeding behavior and energy, where the larvae focus on handling infections that occur in the body (Ali et al., 2019).

NPV infection is divided into 5 stages, namely the attachment of NPV to the cell membrane, cell penetration, biosynthesis of viral components, assembly of viral components, and release of NPV in the form of Polyhedral Inclusion Bodies (PIB) (Asri et al., 2013). Alkaline conditions in the intestinal larvae cause polyhedral dissolution, then virions come out and damage tissues (Putri, A., & Fujiwara, 2015). Exposure to NPV also initiates peritrophic membrane damage, so the longer duration will cause more severe damage (Sanjaya et al., 2010). The virus will continue to replicate and infect other body tissues, such as the epidermis, fat tissue, and trachea. The replication process causes damage to most larvae organs (Bedjo, 2004).

Morphological Changes in The Lambda-Cyhalotrrin Effect

Lambda-cyhalothrin is an active ingredient with contact and stomach exposure (Candra et al., 2018; Indiati, 2007). This active ingredient can react directly when it comes in contact with or through food. In this study, toxic reactions were shown in most larvae that stopped moving on the first day and died on the second day. The carcasses turn brownish red slowly and eventually dry out. These symptoms are similar to what happened in a study conducted by Candra et al. (2018) where Lambda-cyhalothrin caused the death of larvae of nettle caterpillars (*Setothosea asigna*) on the first day that was marked by larvae stopped moving, softened, and the color changed to yellow. According to (Thatheyus & Gnana, 2013) that Lambda-cyhalothrin can close the sodium channel which paralyzes insect locomotor. The residue left on plant organs will also affect the intensity of visiting insects, especially in parts exposed to Lambda-cyhalothrin (Prasetyo et al., 2019).

Morphological damage due to chemical pesticides shows the impact of chemical compounds, which not only kill major pests, but have toxic contents that kill other insects, including decomposers. Studies conducted on a mixture of chemical pesticides with active ingredients malathion, carbaryl, and permethrin show their effects in reducing microbial diversity and changing community structures both in waters and soil (Al-Ani et al., 2019; Muturi et al., 2017). This will have an impact on the duration of the decomposition of the active ingredient and the potential for absorption of the residue in food. Many pesticides are very toxic and even in small quantities, even causing illness and death both in humans and animals (Mishra et al., 2014).

Chemical control is done when the intensity of pests that have exceeded the economic threshold. Chemical pesticides are the last choice over biological or physical control methods, and must be applied in a low volume (Peshin & Zhang, 2014). The effect is not only hitting the target, but also the various animal and plant communities that are closely related in a food network. This impact forms a domino effect on agricultural and economic sustainability.

CONCLUSION

The treatment of NPV and pesticides Lambda-cyhalothrin has an impact on slowing the movement and death of *Spodoptera litura* larvae. The carcasses of the larvae undergo morphological changes which include changes in color, and decay accompanied by the appearance of unpleasant odors, until the drying of the dead larvae. Chemical pesticide treatment has a faster mortality rate compared to NPV treatment, but the rate of morphological changes and decay of larvae carcasses is faster in NPV treatment. Further analysis leads to the impact of NPV on physiological damage and specifically provides parameters for morphological damage and behavioral changes.

ACKNOWLEDGEMENTS

The authors thank the students who assisted in making observations. The authors also thank Agrotechnology Laboratory Assistant who assisted in providing tools and materials.

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