Indian Journal of Entomology Online published Ref. No. e24063 DoI. No.: 10.55446/IJE.2024.2063

GARLIC AS A BOTANICAL PESTICIDE AGAINST ARMY WORM *SPODOPTERA LITURA* (F) ON LETTUCE

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ABSTRACT

Army worm *Spodoptera litura* (F) is one of the potential pests that attack lettuce plants and can cause yield losses. Botanical pesticides from garlic are an alternative to control this. This study aims to determine the most effective concentration and the LC50 value of garlic-based botanical pesticides on the mortality of army worms. This study used a one-factor completely randomized design (CRD) method in the form of botanical pesticides treatment of neem leaf extract (M) with 5 concentration levels with 5 replications; P1 = control, P2 = 10% garlic extract (30 ml extract mixed with 270 ml water), P3 = 20% garlic extract (60 ml extract mixed with 240 ml water), P4 = 30% garlic extract (90 ml extract mixed with 210 ml of water). The treatment of botanical pesticides from garlic caused death of army worms, the most effective concentration was P2 with a mortality of 68% and a mortality rate of 2.5 larva/ hr. The LC50-48, LC50-60 and LC50-72 hr values were 28.09%, 24.09% and 19.10%, respectively.

Key words: Armyworm, botanical pesticide, garlic, lettuce, mortality, *Spodoptera litura* F.*,* dose, dependence, concentrations, extracts, water, solvent

Lettuce (*Lactuca sativa* L.) is a popular vegetable in Indonesia, but its cultivation is frequently hindered by plant pests (OPT), leading to reduced crop production (Rusdy, 2009). According to data from the Central Statistics Agency (2019), lettuce production in Indonesia increased annually. Despite this increase, lettuce cultivation still faces challenges due to pest and disease attacks, resulting in crop loss (Rusdy, 2009). Controlling efforts certainly require knowledge of pests and diseases in order to be able to reduce the decline in existing crop production. Pest attacks on lettuce are a serious problem for farmers. Army worm (*Spodoptera litura* F.) is a potential insect pest that damages agricultural crops or vegetables (Yanuwiadi et al., 2013). Army worms are included in the group of polyphagous pests. The amount of yield loss depends on the level of leaf damage and the stage of plant growth at the time of attack. Leaf damage was 12.5%, causing economic losses equivalent to the cost of two insecticide applications (Tengkano and Suharsono, 2005).

One alternative pest control that can be done is the use of vegetable pesticides. Botanical pesticides are able to control plant pests and diseases by being environmentally friendly and relatively safe from a health perspective (Ruskin et al., 1992). One plant that has the ability to control pests is garlic (*Allium sativum* L.). In research conducted by Sabaruddin (2021), it was discovered that a concentration of 240 g/ ℓ was found to be optimal for repelling army worm. The aim of this research was to determine the effect of vegetable pesticides from garlic on the mortality of army worms, determine the most effective concentration of neem leaves and determine the LC_{50} value of vegetable pesticides from garlic.

MATERIALS AND METHODS

This research employed a one-factor completely randomized design (CRD) to study the impact of garlic pesticide treatments (P) with four concentration levels, each repeated 5 times. The concentration levels were as follows: P1 = control, P2 = 10% garlic extract, P3 = 20% garlic extract, and P4 = 30% garlic extract. The preparation of garlic vegetable pesticides followed the method outlined by Azizah et al., (2020) with modifications, where garlic extract was produced using a 1:1 ratio of garlic to water. A total of 180 ml of extract was required for testing. The process involved crushing 500 grams of peeled garlic and soaking it in 500 ml of water for 24 hr. After soaking, the garlic was squeezed to extract the garlic extract, which was then distributed according to the treatment levels. The application method involved dipping lettuce leaves into the garlic vegetable pesticide solutions corresponding to each treatment level, followed by air-drying. Subsequently, lettuce leaves with 10 armyworm larvae were placed into each test jar. The study monitored armyworm larval mortality on mustard plants treated with neem leaf extract-based vegetable pesticides. Mortality rates were recorded at 12-hour intervals over 72 hr, totaling six observations. The mortality percentage was calculated using the formula M = (a/b) x 100%, where 'M' represents the percentage of larval mortality, 'a' denotes the number of deceased caterpillars per treatment, and 'b' signifies the total number of caterpillars in each treatment. Statistical analysis was performed following the method described by Ordaz-Silva et al., (2016) using Excel software.

The rate of larval death after the application of neem leaf extract was measured every 12 hr for 6 observations using the formula:

V=(T1N1+T2N2+T3N3+···+TnNn)/ n=···head/hour (Setiawan and Supriyadi, 2014); where V = Speed of death; T = Observation time; N = Number of dead caterpillars; and n = number of caterpillars from each treatment. Symptoms of larval death, such as behavior, movement, and body physique changes, were observed every 12 hr for 6 observations, along with other assessments. Tables and figures were provided in a separate page following the references section, adhering to journal format and style for captions and space optimization.

RESULTS AND DISCUSSION

Mortality was calculated to determine the number of armyworms that died after application of botanical pesticides from neem garlic during an observation period of 72 hr. The percentage of mortality can be seen in Fig. 1. The results showed that there was an effect of vegetable pesticides from neem leaves the highest larval mortality was observed in treatment P4 at 86%, followed by P3 at 72%, P2 at 68%, and P1 (control) at 0% or no deaths. Treatments P2 and P3 did not show significant differences. Garlic contains substances toxic to insects, including allicin, saponin, alkaloids, flavonoids, tannins, and sulfur (Yenie et al., 2013). The allicin content contributes to the distinctive smell of garlic botanical pesticides (Hanani et al., 2013). Based on these compounds, it is evident that garlic vegetable pesticides can act as contact, stomach, and respiratory poisons. This study demonstrates that higher concentrations of vegetable pesticides from garlic are more effective in the solution, leading to increased toxic power against pests. This aligns with Rusdy's (2010) view that higher concentrations of garlic extract contain more active ingredients IPM is an approach to pest and disease control based on ecological and economic considerations within environmentally sustainable agroecosystem management (Marwoto, 2007). Isnaini et al. (2015) suggest that the effectiveness of plant-based pesticides can be determined by pest mortality rates reaching 50%. Consequently, P2 is identified as the most effective treatment.

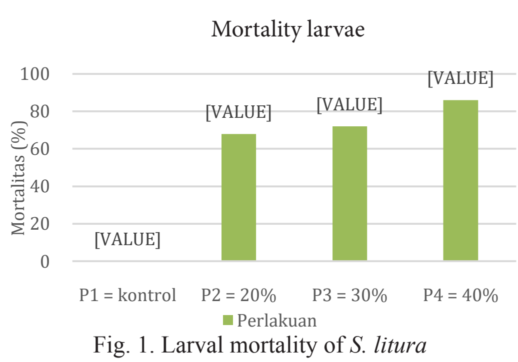

Fig. 1. Larval mortality of *S. litura*

To determine the effect of how large a concentration of vegetable pesticide from neem leaves is needed to kill pests by 50%, a lethal concentration 50 (LC_{50}) test was carried out. The data shows that in observations for 48, 60, and 72 hr or there were treatments that had reached 50% mortality, so the LC50-48h, LC_{50}-60h, and LC50-72h tests were applied. The calculated values can be seen in Table 1.

Table 1. LC50 value of garlic against *S. litura* larvae

LC_{50}-48h (%)	LC_{50}-60h (%)	LC_{50}-72h (%)
28,90	24,09	19,10

The calculation results for determining LC50 showed that the LC_{50}-48h value was 28.09%, LC_{50}-60h was 24.09%, and LC_{50}-72h was 19.10%. From the LC_{50} determination, it can be proven that the vegetable pesticide from neem leaves is known to be toxic and effective in killing 50%. Haditomo (2010) states that the lower the LC_{50} value, the higher the activity of the substance. The LC_{50} probit analysis graph in the form of a linear regression of the relationship between log10 of garlic vegetable pesticide concentration and the probit value of larval mortality is also included. This graph produces a straight line equation for the two relationships which is used to calculate the LC_{50} value. The graph based on the observation time can be seen in Fig. 2. From Figs. 2-4, the straight line equation for 48 hr observations is $y = 3.3828x + 0.0581$ and $R^2 = 0.9912$.

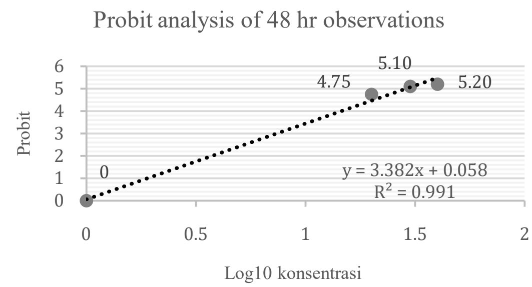

Fig. 2. Relationship- garlic concentration vs. probit value- *S. litura* larva mortality (48 hr).

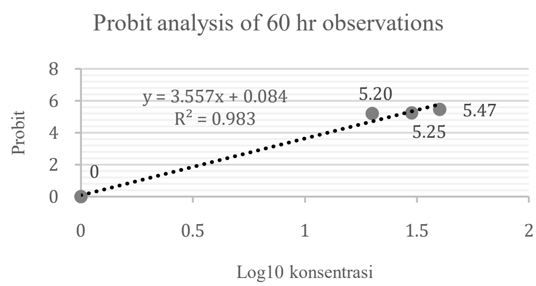

Fig. 3. Relationship- garlic concentration vs. probit value- *S. litura* larva mortality (60 hr)

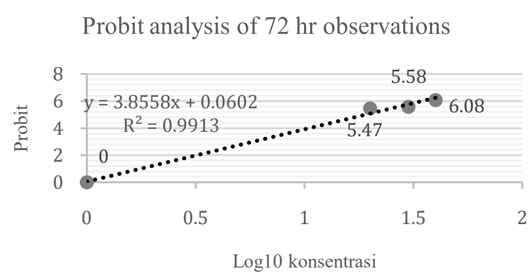

Fig. 4. Relationship- garlic concentration vs. probit value- *S. litura* larva mortality (72 hr)

From 60 hr of observation, the straight line equation was obtained, namely y = 3.5573x + 0.0846 and R^2 = 0.9834. From 72 hr of observation, the straight line equation was obtained, namely y = 3.8558x + 0.0602 and R^2 = 0.9913. Based on the results of the LC50 probit analysis at 48, 60 and 72 hr; it shows that the higher the log10 concentration of the extract from the garlic botanical pesticide, the higher the probit value. The LC_{50} graph also shows the coefficient of determination value, proving that there is a strong influence between log10 concentration on the probit value of corrected mortality. This is as stated by Rusniati and Prijanto (2024) that the R2 value is categorized as strong if it is more than 0.67, moderate if it is more than 0.33 but lower than 0.67, and weak if it is more than 0.19 but lower than 0.33. The rate of larval death shows the number of larvae that died within 72 hr. The average death rate of armyworm larvae is presented in Fig. 5.

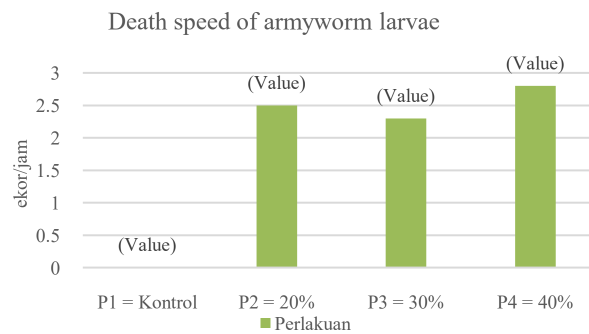

Fig. 5. Death rate for armyworm larvae figure

The results showed that there was an influence of the garlic botanical pesticide on the death rate of armyworm larvae; highest larval death rate was in the P4 treatment at 2.8 individuals/ hr, followed by P2 at 2.5 individuals/hour and P3 at 2.3 individuals/ hr; P2 and P3 are not significantly different. The speed of death is influenced by the active compound content. According to Rizky et al. (2022) that flavonoid compounds themselves function to eradicate insects through the digestive system or stomach toxins when exposed to insects. According to Sasmilati et al. (2017) terpenoid compounds are one of the constituents of essential oils produced by plants. The terpenoids contained in garlic are compounds that have antifeedant properties. This is reinforced by the statement of Budianto & Tukiran (2012), who explain that the nature of insects that refuse to eat can be caused by compounds that interfere with physiological processes.

According to Santoso et al. (2017) that the content of flavonoids, essential oils and tannins can cause the insect's digestive organs to become disturbed and their ability to digest food decreases, their appetite decreases and they eventually die. This ability makes a difference in the speed of death in line with the opinion of Hertlein et al., (2010). Visual observations carried out are known to produce several symptoms. According to Rusandi et al. (2016) that the initial symptoms after pesticide treatment were that armyworm larvae became slow, tended to stay still, body size decreased, the body changed color from green to blackish brown and finally died. This is in accordance with what happened in visual observations carried out by applying garlic vegetable pesticide to armyworms. According to Hasnah and Abubakar (2007), the active compound content of garlic reduces the activity and appetite of larvae, resulting in death. Botanical pesticide treatment from garlic had an effect on the mortality of larvae along with the higher concentration level given to each treatment during the 72 hr observation. The most effective concentration of garlic is known to be the P2 treatment with a mortality rate of 68% for 72 hr and a larval death rate of 2.5 individuals/ hr. The LC50-48h, LC50-60h and LC50-72 h values are 28.09, 24.09 and 19.10%, which indicates that vegetable pesticides from garlic are effective.

ACKNOWLEDGEMENTS

Constructive feedback provided by the anonymous reviewers is acknowledged.

FINANCIAL SUPPORT

This work not supported by any funding sources.

AUTHOR CONTRIBUTION STATEMENT

All authors have contributed equally to the manuscript.

CONFLICT OF INTEREST

No conflict of interest

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(Manuscript Received: March, 2024; Revised: April, 2024;
Accepted: July, 2024; Online Published: July, 2024)
Online First in www.entosocindia.org and indianentomology.org Ref. No. e24063