Mortality and Attack Intensity of *Spodoptera exigua* on Shallots with Clove Essential Oil Application

Ziza Adisty[1] Ahmad Taofik[1] Ida Yusidah[1] Efrin Firmansyah[1,*]

[1] *Department of Agrotechnology, Faculty of Sciences and Technology, UIN Sunan Gunung Djati, Bandung Indonesia*
[*] *Corresponding author. Email: efrin@uinsgd.ac.id*

ABSTRACT
Shallots are a favorite vegetable crop because they are widely used in daily cooking spices. The cultivation of this plant is constrained by the attack of plant pest organisms like *Spodoptera exigua*. *S. exigua* causes damage by causing scallions to become hollow and see-through. Alternative control of *S. exigua* attack is by using clove essential oil. The study was conducted in West Bandung, West Java from June to August 2021. This study used a Randomized Block Design with 5 treatments and 5 replications, namely: Control (without essential oil), clove essential oil concentration of 2.5%, clove essential oil concentration of 5%, clove essential oil concentration of 7%, and clove essential oil of 9% concentration. The results showed that clove essential oil (*Syzygium aromaticum*) with a concentration of 9% was the most influential treatment for the highest mortality and the lowest intensity of pest attack.

Keywords: *Spodoptera exigua, clove essential oil, shallot.*

1. INTRODUCTION

One of the factors causing the need for shallots to be unfulfilled in the wider community is pest attacks. According to [1], the Allium genus, especially the *Allium cepa* is a type of shallot that is susceptible to pests causing damage to shallot plants. One of the most dominant pests that attack this plant is *Spodoptera exigua*. *S. exigua* is a cosmopolitan insect that is an important pest on shallot plants [2]. *S. exigua* has the ability to rapidly spread on shallots in the lowlands and highlands, besides that the pest attacks shallots throughout the year, during both dry and rainy seasons. *S. exigua* larvae attack leaf and shallot plants with general symptoms of leaf-boring larvae and making holes at the tips of the leaves by eating the inside of the leaves so that the leaves look dreamy and only the epidermis of the leaves remains, in severe attacks, the leaves will be cut into pieces and the leaves will fall drooping [3]. The method of controlling pests in shallots cultivation that is widely used were chemicals or synthetic pesticides.

The use of insect repellent poisons (insecticides) is widely used to reduce the number of pests. However, the use of synthetic pesticides causes resistance to target pests when used continuously and can contaminate food ingredients so it is dangerous for consumers because they contain high residues of insecticides. Alternative control can be using natural insecticides, one of which is the use of essential oils as a contact poison. The biological activity of essential oils on insects can be repellant, attractant, contact poison, respiratory poison, antifeedant, oviposition deterrent, inhibit growth and development, and reduce fertility [4]. According to [4], essential oils can be found in plant parts, for example in roots (vetiver), on stems (cinnamon), on flowers (cloves), and on fruit (nutmeg). One of the plants that are used as an essential oil is the clove plant. According to [5], the use of clove essential oil has an effect on the mortality of *S. exigua*. The percentage of effective mortality of *S. exigua* larvae was with a concentration of clove essential oil of 2.5% with a mortality percentage of 94% in the laboratory condition. Based on this, the use of clove essential oil (*Syzygium aromaticum*) is expected to be able to be used as an alternative control material in controlling *S. exigua* on shallot plants in the field.

2. METHODS

The method used was a randomized block design (RBD) with 5 treatments and 5 replications. The treatments namely: p0 = without clove essential oil (control); p1 = clove essential oil solution with a concentration of 2.5%; p2 = clove essential oil solution with concentration of 5%; p3 = clove essential oil

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solution with a concentration of 7%; and p4 = clove essential oil solution with a concentration of 9%.

2.1 Mortality

Total Mortality of *S. exigua* larvae (%) It was carried out after the application of essential oils by counting every dead larva in each experimental unit 1-7 days after application. To find out the total percentage is calculated using the following formula :

$$M = \frac{a}{a+b} x\ 100\% \quad (1)$$

M = Percentage of pest mortality

a = Number of dead pests

b = Number of living pests

2.2 Attack Intensity

It was carried out at the end of the observation, which was 7 days after the application of clove essential oil. The intensity of pest attack is calculated by the formula as follows:

$$I = \sum \frac{nxv}{ZxN} x100\% \quad (2)$$

Information : I = Attack intensity (%)

n = Number of plants that have the same damage scale category

v = Damage scale value of each attack category

Z = Highest damage scale value

N = Number of plants observed

Leaf score is determined based on the number of affected leaves with the following conditions: 0 = No damage to leaves 1 = 1-25% leaf damage 2 = Leaf damage by 26-50% 3 = Leaf damage by 51-74% 4 = Leaf damage by 76-100%.

Data were analyzed by ANOVA and Duncan Multiple Range Test (DMRT) 5%.

3. RESULT AND DISCUSSION

Based on the results of analysis of variance, the concentration of clove essential oil significantly affected the mortality of *S. exigua* larvae. The results of the Duncan Multiple Range Test (DMRT) further test (Table 1), the mortality of *S. exigua* larvae showed a significant difference between the control and treatment E. The control treatment showed the lowest mortality of 78% while the clove essential oil concentration of 9% showed the highest mortality (90%). This indicated that clove essential oil had an effect on mortality of *S. exigua*. The content of secondary metabolites in clove essential oil is able to resist or kill, and reduce the population of *S. exigua*. One of the secondary metabolites in clove essential oil is flavonoid. Flavonoids are thought to be able to enter through the cuticle that covers the larvae so that it can damage the respiratory system of the larvae.

Table 1. Effect of Clove Essential Oil on Larval Mortality (%)

Concentrations (%)	Mortality rate (%)
A= Control	78.0 a
B= 2.5%	85.3 ab
C= 5.0%	86.7 ab
D= 7.0%	85.3 ab
E= 9.0%	90.0 b

Note: The numbers followed by the same letter indicate that they are not significantly different according to the DMRT test at the 5% level.

According to [6], flavonoids enter the insect's body through the respiratory system and then cause damage to the respiratory system, causing mortality. In addition to flavonoids, there are also other ingredients such as saponins. Saponins are bioactive compounds as toxins that are included in the contact poison class because they can enter through the body wall of the larvae and saponins also have a bitter taste that reduces the appetite of the larvae so that the larvae that eat them will die of starvation [7]. Another ingredient containing clove essential oil is tannins. Tannins are metabolites that can interfere with insects digesting food. This happens because tannins will bind to proteins in the digestive system that insects need for growth so that the process of protein absorption in the digestive system is disrupted [8]. Tannin metabolites can suppress appetite, growth rate and survival ability.

Based on the analysis of variance, the concentration of essential oils significantly affected the intensity of plant damage (attack by pest). Based on Duncan's test, it showed that there was a significant difference between the control and the treatment. The value of the intensity of damage caused by *S. exigua* is relatively small. This can be seen in shallots with relatively few symptoms of *S. exigua* bites. However, in the field, it was identified that the damage to the shallots was quite high, which was caused by the symptoms of fusarium wilt disease which was quite high with a percentage of 65% as shown in the table. So that most of the damage caused by fusarium wilt attack and the damage caused by *S. exigua* larvae on shallot plants is quite small.

Overall, the phytochemical content of clove essential oil that has a fast response to *S. exigua* mortality is saponins, flavonoids and tannins which are able to act as larvicides through the mechanism of damaging cell membranes or disrupting larval metabolic processes. In addition, another thing that causes high larval mortality is the incompatibility of the environmental temperature

on the day of application with the optimal temperature required for the growth and development of the *S. exigua* population. According to [9], the optimal temperature required for the growth and development of the *S. exigua* population is 28-30ºC. Meanwhile, the ambient temperature on the day of application has an average temperature of 23.3ºC, which is lower than the recommended temperature.

Table 2. Effect of Clove Essential Oil on attack intensity (%)

Concentrations (%)	Attack Intensity (%)
A= Kontrol	0.6211 b
B= 2.5%	0.5787 a
C= 5.0%	0.5413 a
D= 7.0%	0.6029 a
E= 9.0%	0.6184 a

Notes: The numbers followed by the same letter indicate that they are not significantly different according to the DMRT test at the 5% level

According to Moekasan *et al.,* [9] high temperatures can affect the life cycle of *S. exigua* to be shorter so that *S. exigua* eggs hatch more quickly into larvae. Therefore, high larval mortality also occurred due to the incompatibility of environmental temperature with the optimal temperature for growth and development of *S. exigua* larvae.

4. CONCLUSION

The clove essential oil (*Syzygium aromaticum*) with a concentration of 9% was the most influential treatment for the highest mortality and the lowest intensity of pest attack.

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