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Effect of Biopesticide Application in Suppressing the Population of Onion Caterpillar Pests (*Spodoptera exigua L*) in Shallot Plants (*Allium ascalonikum L*)

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Abstract

Shallot is one of the leading vegetable commodities that has long been cultivated by farmers intensively This commodity is also a source of income that contributes quite high to the economic development of the region, because it has a high economic value, onion cultivation has spread in almost all provinces in Indonesia. The type of pest that is often found in shallot plants is the onion caterpillar (*Spodoptera exigua L.*). Shallots are the main host for S.exigua larvae. Yield loss due to this pest attack can reach 57% because it occurs from the initial growth phase to the bulb maturation phase, and can even result in crop failure, especially in the dry season if control is not carried out as soon as possible. One way that can be used to suppress the growth of onion caterpillars on shallots is by using vegetable pesticides. Vegetable pesticides contain active compounds that can interfere with the development process of onion caterpillars. The method in this research is Non Factorial Randomized Group Design with each treatment: DO= (control), Dl= 100 ml (each of neem, lemongrass and galangal leaves)/liter of water, D2= 200 ml (each of neem, lemongrass and galangal leaves)/liter of water, D3= 300 ml (each of neem, lemongrass and galangal leaves)/liter of water and D4= 400 ml (each of neem, lemongrass and galangal leaves)/liter of water. The results showed that the biopesticide treatment showed a significant effect on all treatments, namely attack intensity, percentage of attack, fresh tuber weight and dry tuber weight. The best treatment was found in D4, namely the application of biopesticides at a dose of 400 ml (each of neem, lemongrass and galangal leaves)/liter of water.

Keywords: Shallot, Biopesticide, Onion caterpillar (*Spodoptera exigua L*)

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1. Introduction

Based on statistical data, national shallot productivity in 2020 was 9.54 tons per hectare and 893,124 tons in the same year. The data decreased from 2010 where national production reached 1,048,934 tons with a productivity of 9.57 tons per hectare (BPS, 2020). It can be said that the national shallot productivity is still low, while the national shallot demand continues to increase with the rate of population increase, so it is necessary to optimize shallot cultivation (Hidayat, 2004).

One of the obstacles in shallot cultivation in Indonesia is the attack of onion caterpillar pests (Spodoptera exigua L.) which is the main pest in shallot plants. If not controlled, the pest attack can cause crop failure (Moekasan et al., 2012). The presence of pest attacks on shallot plants causes farmers to try to protect their plants from damage by chemical means using synthetic insecticides.

Pesticide poisoning is one of the most common public health problems in developing countries. It is estimated by the World Health Organization (WHO) that about 18.2 per 100,000 agricultural workers experience work-related pesticide poisoning worldwide (Thundiyil et al., 2008). In addition, more than 168,000 people die from pesticide poisoning each year, with most coming from developing countries (Semugabo et al., 2017).

The use of pesticides that do not meet the rules will have many impacts, including health impacts for humans, namely the increased risk of miscarriage, infertility and in pregnant women can cause birth defects. Exposure to pesticides in children can reduce body stamina, reduce intelligence and concentration levels. Chemical poisons made from chlorine can cause breast cancer (Silowati, 2015). Therefore, from 1976 to 2000, the government has banned the use and circulation of 119 pesticide formulations with 67 types of active ingredients (Wahyono and Rachmad, 2014).

Presidential Instruction (INPRES) No. 3/1986 which was later enacted as Law No. 12 of 1992 article 20 on Plant Cultivation System, which is related to pests that plant protection is implemented with an integrated pest control system (IPM). One of the practical objectives of the IPM system is to reduce the quantum of pesticide use. One way is to introduce natural pesticides that are able to protect the efficacy of these synthetic pesticides with minimum negative impacts.

Pesticides obtained from both plants and microorganisms are called biopesticides. The workings of bioactive molecules contained in biopesticides can function as biotoxic (toxic), antifeedant, feeding deterrent, repellent, and or other natural disruptors. Biopesticides contain various active compounds and have multiple modes of action, both as poisons, feeding deterrents, disruptors of life development processes, and repellent substances (EPA. 2000).

The large diversity of natural resources (biodiversity) of plants such as bandotan, forest betel, brotowali, temulawak, mahkota dewa seeds, spring, soursop leaves, neem leaves, tobacco, bengkuang seeds, cloves, garlic, amethyst leaves, pepper and betel leaves as a source of biopesticides, is still not maximally utilized even though the potential is quite large. The importance of developing biopesticides has several advantages, including being environmentally friendly, cheap and easy to obtain, not poisoning plants, not causing pest resistance, containing nutrients needed by plants, compatible with other controls and producing agricultural products that are free of pesticide residues.

Some ingredients that can be combined in making biopesticides include neem leaves, lemongrass and galangal. Galangal rhizome contains galangin, galangol, pinen, chamfer, methyl cyanate, eugenol, sesquiterpenes, and sineol, which are antibiotics. The content of essential oils whose components are acetyl cyanate, sineol, chamfer, and galangin act as biotoxins and repellent substances (Julianto, 2019). The active ingredients of essential oil in galangal are anti-bacterial and anti-fungal. Neem contains the active ingredients azadirachtin (C35 H44 0 16), meliantriol, salanin, and nimbin which can affect feeding power, growth and reproductive power of insects, affect the process of molting, and inhibit the formation of adult insects. Meanwhile, lemongrass has an active ingredient of 49% silica so that it can cause desiccation, namely continuous fluid loss if the insect's body is injured (Antoni, et al., 2021). In addition, lemongrass contains citronella compounds contained in essential oils and is disliked by insect pests (Mumba and Rante, 2020). These compounds are anti-fungal, anticonvulsant, anti-parasitic, anti-inflammatory, and anti-oxidant. Therefore, the use of biopesticides with a combination of neem, lemongrass and galangal leaves containing various bioactive compounds can be used to control shallot caterpillar pests.

This study aims to determine the effect of neem, lemongrass and galangal leaf biopesticide applications in suppressing the population of onion caterpillar pests (*Spodoptera exigua* L) on shallot plants (*Allium ascalonikum L*)

2. Materials and Methods

a.Time and Places

This research was completed from September to December 2021 in the crop field of Batang Bahai Village, Padangsidimpuan Batunadua Sub-district at an altitude of 322 meters above sea level (masl).

b. Materials and Tools

Materials used in this study include neem leaves, lemongrass, galangal, distilled water, label paper, soil, SP-36, Phonska and polybags.The tools used in this research include, among others, handsprayer, plastic, spatula, blender, knife, analytical scales, drum and stationery.

c. Research Method

This study used the Randomized Group Design (RAK) method consisting of 5 treatments and 5 replicates:

DO : 0 ml (neem, lemongrass and galangal leaves) (control)

DI : 100 ml ((each of neem, lemongrass and galangal leaves)/ liter of water

D2 : 200 (each of neem, lemongrass and galangal leaves)/liter of water

D3 : 300 ml (each of neem, lemongrass and galangal leaves)/liter of water

D4 : 400 ml (each of neem, lemongrass and galangal leaves)/liter of water

The data obtained were analyzed with variance analysis, if there is a difference, it will be continued with the Duncan Multiple Range Test (DMRT) test at the 5% error level.

d. Research Implementation

Shallots are planted in a container that already contains soil. The part of the shallot that is planted is the bulb. The bulb is cut 1/3 of the tip to equalize the growth of the initial shoot. The criterion for the weight of shallots used is to have a uniform weight of 3-5 grams.To make biopesticides adjusted to the treatment dose to be used. All ingredients are chopped, mixed and then ground until smooth, 2l water is added, stirred for 5 minutes, the suspension is deposited for 24 hours. Biopesticides were sprayed to all parts of the plant in the afternoon. with an application interval of once a week.

Biopesticide application was applied directly to the plants 2 weeks after planting. Applications were made in the morning or evening with an interval of 7 days. Observations started from the first application with an interval of 7 days until the plants were 1 week old before harvest.

Parameters observed in this study include Pest Attack Intensity with the formula:

$$I = \frac{n}{N}\, x\, 100\%$$

Description: :

I : Attack Intensity

n : Number of plant leaves that are attacked

N: Number of leaves observeddiamati

While the percentage of infested plants was observed with the formula:

$$P = \frac{a}{a+b}\, x\, 100$$

3. Results and Discussion

a. Pest Attack Intensity

The results of observations of the level of attack of shallot caterpillar pests (Spodoptera exigua L.) on shallot plants can be seen in Table 1. Based on the analysis of variance in Table l. shows that the intensity of onion caterpillar attack (Spodoptera exigua L.) at the age of 2 weeks after planting and 4 weeks after planting did not show significant differences among all treatments. At the age of 2 weeks after planting, the level of caterpillar pest attack on shallot plants was still low, ranging from 0.05-0.14%.

This is thought to be because the leaves of shallot plants are still small but the intensity of caterpillar pest attacks has increased at the age of 2 weeks after planting, which ranges from 0.47-0.61%. The highest average intensity of attack was found in the DO treatment (control). The increase in the intensity of caterpillar pest attacks can be caused by external and internal factors. This is in accordance with the opinion of Azis (2017) which states that the imago population increases at the beginning of planting until flowers appear, then continues to decline. The increase in population until the generative phase is due to the availability of leaves for egg laying increases as well.

Based on the analysis of variance in Table. 2 shows that treatment D0 (control) is not significantly different from treatment D1 (100 ml biopesticide/liter of water), but significantly different from D2 (200 ml biopesticide/liter of water), D3 (300 ml biopesticide/liter of water), and D4 (400 ml biopesticide/liter of water). The lowest average percentage of attack was found in treatment D4 (400 ml biopesticide/liter of water) which was 0, 14%. Based on the indicators and criteria for the level of S. exigua attack on onion plants, it shows that the attack on shallot plants is included in the criteria for a very low level of attack because the percentage of attacks of the two varieties of shallots ranges from 0-10%. The biopesticide used in this study is a mixture of neem, citronella and galangal.

Neem is one of the plant species from the Meliaceae family that contains quassinoid, limonoid, and terpenoid biotoxin compounds. One of the components of azadirachtin with its model of action that functions as an insecticide is a feeding inhibitor and growth inhibitor. The secondary metabolic compounds of azadirachtin are very broad-spectrum biocides and have a model of action that affects the process of mitosis and meiosis by blocking the synthesis of DNA and RNA in the microlubule assembly process. Therefore, azadirachtin is also antiplasmodium, antiviral, and antifungal because it is able to inhibit cell development - The biotoxin compound azadirachtin is identical to benzimidazole.

Other active ingredient molecules are meliantriol, salamin, and while azadirachtin itself contains 17 bioactive components that play the most pesticidal role. Citronella is one of the plant species of the Graminae family, containing the biotoxin compounds citronelo, geraniol, nerol, farnesol, methyl heptenone, and also dipentene. Farnesol is a sesquiterpene compound that is toxic and allergenic (Julianto, 2019).

Galangal rhizome contains essential oils that can inhibit the growth of several species of pathogenic fungi (Yuharmen, 2002). Galangal rhizome is efficacious as an anti-fungal and anti-bacterial. The mixture of the three plants was found to be able to control various pests.

b. Fresh Weight of Shallot Bulbs

The fresh weight of bulbs on shallot plants is weighed using analytical scales, the average fresh weight of bulbs can be seen in Table. 3. Based on the results of the analysis of variance in Table. 3 shows that the DO treatment (control) is significantly different from the D3 treatment (300 ml biopesticide / liter of water) and D4 (400 ml biopesticide / liter of water). The highest average was found in the D4 treatment which was 81.87 grams, this was thought to be because the biopesticide with a dose of 400 ml was able to suppress pest attacks and improve shallot production.

According to Haryati and Nurawan (2009), in their research stated that the high or low production of shallots is strongly influenced by the attack of Spodoptera exigua L. on shallot plants. Production and attack have a relationship that the higher the attack, the lower the production (Sarwono, 2006). All biopesticide treatments are able to suppress the attack of S.exigua pests on plant leaves, so that plant damage due to shallot pests can be suppressed, the weight of the yield of bulbs attacked by these pests can be reduced and the weight of the yield of healthy bulbs can be increased.

According to (Purbiati 2010), plant growth and growth are strongly influenced by external and internal factors. One of the internal factors is the genetic characteristics of the variety. Conversely, external factors are climate, temperature, humidity, rainfall, nutrient availability and sunlight intensity.

Host plants are plants that can meet the needs of insects, both related to behavior and nutritional needs. The relationship between host and insect is a series of interaction processes, including the mechanism of host plant selection, utilization of the host plant as a food source as well as shelter and egg laying. Insects reproduce faster on suitable host plants and vice versa development becomes slower on host plants. Less suitable host plants. Differences in the level of suitability can occur in plants of different species or in plants of the same species (Fachrudin, 1980).

c. Dry Weight of Shallot Bulbs

The dry weight of bulbs on shallot plants is weighed using analytical scales, the average fresh weight of bulbs can be seen in Table. 4. Based on the results of the analysis of variance in Table. 4 shows that the DO treatment (control) is significantly different from the D3 treatment (300 ml biopesticide / liter of water) and D4 (400 ml biopesticide / liter of water).

Onion plants have two phases of growth, namely the vegetative phase and the generative phase In the generative phase, there is what is called the formation of bulbs 36-50 HST and the phase of maturation of bulbs 51-65 HST. Harvested shallots are dried to prevent damage caused by fungi or bacteria (Samadi, 2005). The drying process was carried out by sun drying for 7 days according to the ambient light intensity.

The dry weight of meralı onion plants in all control and biopesticide treatments showed the highest weight was in treatment D4, namely 400 ml of mixed biopesticide with an average of 70.67.

The use of biological agents as biological pesticides is better to apply. This is in accordance with the statement of Nurdin et al. (1993), which states that biological pesticides can be used as one component in integrated control because they are effective against target pests and relatively safe against parasitoids and predators.

Table 1. Average Attack Intensity of Shallot Caterpillar (Spodoptera exigua L.) at the age of 2, 4 and 6 Weeks After Planting and the Results of Analysis of Variance

Treatment	Attack intensity (%)		
	2 Week	4 Week	6 Week
D0 (Control)	0,14	0,61	0,09 a
D1(100 ml biopesticide/ L water)	0,14	0,58	0,08 a
D2 (200 ml biopesticide/ L water)	0,09	0,47	0,07 a
D3 (300 ml biopesticide/ L water)	0,13	0,57	0,03 b
D4(400 ml biopesticide/ L water)	0,05	0,50	0,02 b

Description: Numbers followed by the same letter in the same column indicate no significant difference between treatments (ANOVA with DMRT test at a = 0.05).

Table 2. Average Percentage of Attack and Attack Rate of Shallot Caterpillar (Spodoptera exigua L.) and the Results of Variance Analysis

Treatment	Percentage Attack (%)	Attack Rate
D0 (Control)	0,36 a	Very Low
D1(100 ml biopesticide/ L water)	0,33 a	Very Low
D2 (200 ml biopesticide/ L water)	0,24 b	Very Low
D3 (300 ml biopesticide/ L water)	0,16 bc	Very Low
D4(400 ml biopesticide/ L water)	0,14 c	Very Low

Description: Numbers followed by the same letter in the same column indicate no significant difference between treatments (ANOVA with DMRT test at a = 0.05).

Table 3. Average fresh weight of shallot bulbs and the Results of Variance

Treatment	Fresh Weight (gram)
D0 (Control)	47,70 a
D1(100 ml biopesticide/ L water)	48,36 a
D2 (200 ml biopesticide/ L water)	58,91 ab
D3 (300 ml biopesticide/ L water)	67,56 bc
D4(400 ml biopesticide/ L water)	81,87 c

Description: Numbers followed by the same letter in the same column indicate no significant difference between treatments (ANOVA with DMRT test at a = 0.05).

Table 4. Average dry weight of shallot bulbs and the Results of Variance Analysis

Treatment	Dry Weight Treatment (gram)
D0 (Control)	36,47 a
D1(100 ml biopesticide/ L water)	39,96 a
D2 (200 ml biopesticide/ L water)	47,94 ab
D3 (300 ml biopesticide/ L water)	56,01 bc
D4(400 ml biopesticide/ L water)	70,67 c

Description: Numbers followed by the same letter in the same column indicate no significant difference between treatments (ANOVA with DMRT test at a = 0.05).

4. Conclusions

Biopesticides of neem leaves, lemongrass and galangal are able to suppress shallot caterpillar pests with a significant effect on all treatments. The best treatment is found in D4, namely biopesticide with a dose of 400 ml (each neem leaf, lemongrass and galangal) / liter of water.

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