International Journal of Design & Nature and Ecodynamics
Vol. 17, No. 2, April, 2022, pp. 289-296
Journal homepage: http://iieta.org/journals/ijdne

Extract of *Nerium oleander* L. Effectively Inhibit Population of *Spodoptera exigua* (Hubner.) on Palu Shallot

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https://doi.org/10.18280/ijdne.170216

Received: 4 October 2021
Accepted: 2 April 2022

Keywords:
extract, Nerium oleander, Spodoptera exigua, shallot

ABSTRACT

One of the obstacles in shallot cultivation is the *S. exigua* Hubner larvae attack, reducing crop yields. The efforts to control larvae attack using chemical pesticides are often carried out. One of the alternatives chosen to control the larvae attack is the use of Nerium (*Nerium oleander L.*) leaf extract. This plant has the potential as a larvicide because it is toxic. The study's main goal was to figure out what effect a certain concentration of *N. oleander* leaf extract had on the population density and attack intensity of *S. exigua* larvae. The investigation was carried out between December 2018 and February 2019. P0= 0 g/l (without treatment), P1= 2.68 g/l (0.268%), P2= 5.37 g/l (0.537%), P3= 10.75 g/l (1.075%), P4= 21.5 g/l (2.15%), and P5= 43 g/l (4.3%) were employed in the study. The randomized block design (RBD) was utilized in the study, and it was repeated four times. The findings revealed that increasing the quantity of *N. oleander* leaf extract may reduce the population density and attack intensity of *S. exigua* larvae while simultaneously increasing the output of Lembah Palu shallots. Generally speaking, the higher the concentration of *N. oleander* leaf extract, the lower the population density of *S. exigua* larvae, and the larger the shallot yield. It is necessary to use the effective concentration of *N. oleander* leaf extract, which is P3 (10.75 g/ha) with a production rate of 7.29 tons/ha in order to get the desired results.

1. INTRODUCTION

The primary pest that attacks shallot plants is *Spodoptera exigua* [1]. Yield losses caused by these pests can reach 20-70% [2]. Shallot caterpillar *S. exigua* is one of the shallot plant pests that attack throughout the year, both in the dry and rainy seasons [3].

The Central Statistics Agency of Central Sulawesi Province shows that in 2017 the area of shallot harvested reached 1,297 ha, with production reaching 11,511 tons, with yield per hectare bearing 8.75 t/ha, decreased production to 4.12 t/ha in 2018. Various efforts to increase the productivity of shallots include improving cultivation techniques. Still, the problem of pests and diseases is one of the determining factors in increasing the productivity of shallots [4].

In general, shallot farmers, especially in the Palu Valley, still rely on spraying synthetic pesticides, which are carried out every 2-3 days to overcome the attack of *S. exigua* caterpillars by using high doses even by mixing several types of pesticides in one application [5, 6]. Control in this way is considered more effective because it can reduce pest populations relatively quickly. Still, continuous and excessive use of pesticides can cause negative impacts such as pest resistance, resurgence, residue problems, environmental pollution and the killing of natural enemies of pests and have a negative effect against non-target organisms such as humans [7, 8] and ecosystem damage [9, 10].

To reduce the negative impact of using synthetic pesticides, it can be done by using natural ingredients like environmentally friendly pest control materials. Various types of plants that have insecticidal properties have been reported by many researchers such as andaliman (*Zanthoxylum acanthopodium*) and cashew (*Anacardium occidentale*) plant extracts as vegetable insecticides for cabbage caterpillar *Plutella xylostella* and apis *Brevicoryne brassicae* [11], extract of neem (*Azadirachta indica*) for the control of *Sitophilus zeamais* on maize seeds [12, 13], *S. littoralis* (Boisd.) on cotton plants and *S. exigua* (Hubner) on shallots [14], soursop leaf extract (*Annona muricata*) for the control of *Riptortus linearis* in soybeans [15], papaya leaf extract (*Carica papaya* L.) for the control of *Leptocorisa acuta* in rice plants [16], as larvicides [17], herbicide [18], and insecticide [19] butter flower extract (*N oleander*) as a poison that can control larvae.

The plant parts of *N. oleander* that can be used as vegetable insecticides are roots, stems, bark, leaves and flowers, but the leaves are the most commonly used because they contain the most oleandrin [19]. The substance works as a stomach poison and inhibits the larvae's eating power. Stomach poison will affect the metabolism of the larvae after eating the poison. Then the poison will enter the body and dig into the central channel, which is circulated with fluids that function like blood. The poison carried by the liquid will affect the nervous system of the larvae and will then cause death [20, 21].

The use of *N. oleander* for pest control of shallot caterpillars has never been done, so it is important to do testing to optimize its use. Some of the literature above indicates that *N. oleander* can be used as a bioinsecticide against several types of insects [17, 19]. So it can also be used as a control of *S. exigua* larvae on shallot plants.

The study aimed to determine the effectiveness of the leaf extract of *N. oleander* as a vegetable insecticide on the population and intensity of shallot caterpillar attacks in the dry land.

2. MATERIALS AND METHODS

2.1 Time and location

Between December 2018 and February 2019, the study was conducted in Sidera Village, Sigi Biromaru District, Sigi Regency, Central Sulawesi Province, Indonesia. The study site is located at an elevation of 220 meters above sea level. This region was chosen due to *Spodoptera exigua* larvae attacking native shallots in Sidera (Figure 1).

2.2 Tools and materials

A hand tractor (Yanmar), a blender, a hoe, a hand sprayer, an analytical scale, a measuring cup, a bucket, a cutter, a sieve, a filter (gauze), a camera, and a stationary workstation were all utilized in this investigation. The materials used were shallot seeds of Lembah Palu, *N. oleander* leaf extract, cow manure, NPK fertilizer and water [22].

2.3 Research method

This research was prepared using a Randomized Block Design (RBD) [23]. Consisting of 6 treatments and 4 replications to obtain 24 plots. The grouping was made based on the size of the seeds. The treatments were as follows: P0: Control (No treatment), P1: 2.68 g/l (0.268%), P2: 5.37 g/l (0.537%), P3: 10.75 g/l (1.075%), P4: 21.5 g/l (2.15%), and P5: 43 g/l (4.3%) [24].

2.4 Research technique

2.4.1 Soil cultivation

The soil was cultivated using a hand tractor to break down the dirt and clean up crop residues and weeds. Then, the hoe was used to loosen and flatten the ground and make a 2 x 1-meter plot, the distance between the properties was 50 cm [25].

2.4.2 Planting

The end of the selected seed is cut to equalize shoot growth. Planting the seeds is carried out one week after giving the cow manure to the plots. The seeds were planted perpendicularly at a 15 x 15 cm spacing so that there were 78 seeds in one research plot. The day before planting, the plots were watered to field capacity. Therefore, the planting of Lembah Palu shallots manually can be done quickly [4].

2.5 Plant maintenance

Plant maintenance using cow manure as basic fertilizer, with a dose of 4 kg plot/-1 by distributing it evenly one week before planting. Then, when the onion plants are two weeks old, follow-up fertilization is carried out with 0.25 Kg/Plot NPK. Weeds that grow around the plant are removed and then buried back into the soil. Watering the plants is done twice a day every morning and evening until the plants are 10 days old. Furthermore, the frequency of watering is done once a day in the afternoon until the age of the plant is 55 days.

2.6 *N. oleander* L. leaf extract making

The leaves of *N. oleander* are cut into small pieces and dried in an oven at 40°C for 1x24 hours, then blended until they become powder and sift into flour. Then, *N. oleander* flour was weighed according to treatment and soaked in water for 2x24 hours. The soaking product was filtered using gauze to produce *N. oleander* leaf extract, which was ready to be applied to Lembah Palu shallot plants [26].

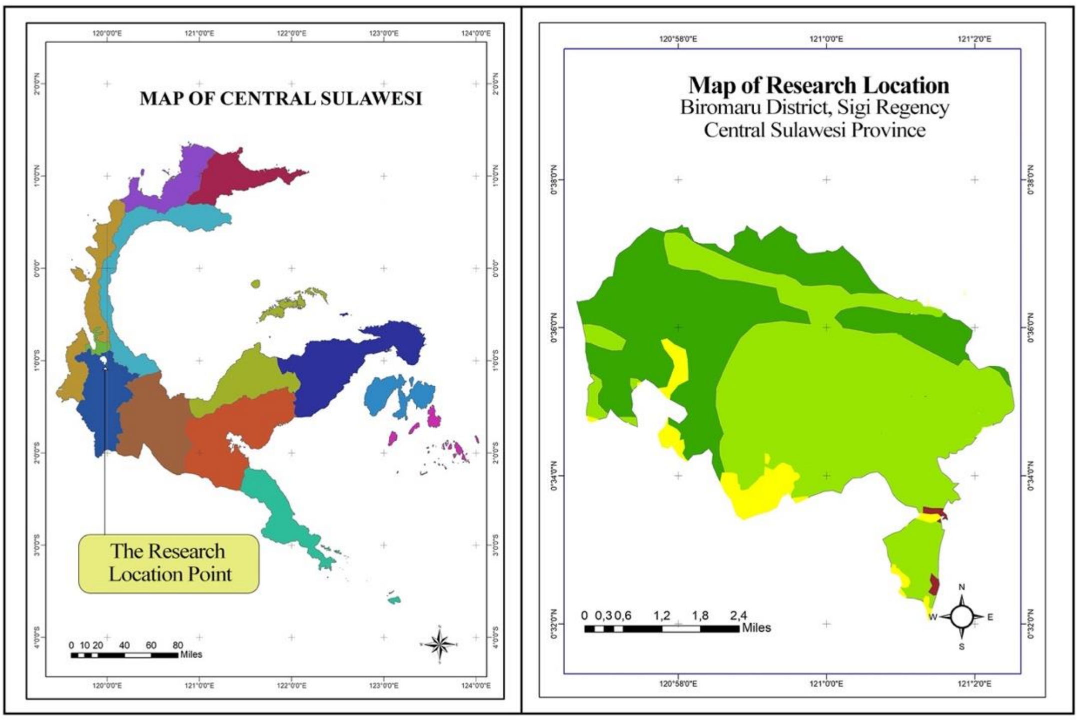


Figure 1. Research site map

2.7 *N. oleander* L. leaf extract application

Application of *N. oleander* leaf extract in each treatment with a volume of 120 ml/plot using a hand sprayer with a capacity of 2000 ml. This was done when the plant was 14 days after planting, when the plant was attacked by *S. exigua* larvae with a spraying interval of 1 week [27].

2.8 Observation variable

2.8.1 Population density of *S. exigu* larvae

Observation of larvae population density was carried out on 20 samples of Lembah Palu shallot plants per plot and labelled. The number of all sampled plants observed was 480 clumps of Lembah Palu shallot plants. Observations were started seven days after application (21 DAP) to 56 days after planting (56 DAP).

2.9 *S. exigua* larvae attack intensity

2.9.1 Observation

The attack intensity observation was carried out by counting the number of local shallot plants of Palu that were attacked by *S. exigua* larvae in 20 samples of shallot plants per plot labelled using wooden stalks [28]. Then, the intensity of the absolute attacks was calculated using the formula below:

$$I = \frac{a}{b} x100\% \quad (1)$$

Description:
I = Attack intensity (%);
a = The number of attacked plants;
b = The number of observed plants.

The intensity of the attack was measured based on the number of plants compared to all plant samples.

2.10 Shallot production

Production observations were carried out by weighing the yield of shallot from each treatment plot (g/plot), then converted into tons/ ha, using the following formula:

$$\text{Y (ton/ha)} = \frac{\text{X (kg)}}{\text{L(m}^2\text{)}} \; x \; \frac{10.000\text{m}^2}{1000 \text{ kg}} \text{ x } 80\% \quad (2)$$

Description:
Y = Production in ton/ha;
X = Production in kg/plot;
L = Plot Area.

That, 80% is the crop coefficient. This means that there are 80% of plants fill one stretch. In contrast, 20% is plot and drainage land.

2.11 Data analysis

An analysis of variance (ANOVA) was performed in order to assess the influence of therapy on the outcome. If the analysis of variance reveals a significant influence, the team will move to the Honestly Significant Difference Test at the 5 percent level, which will be performed with SPSS version 26 [29].

3. RESULT

3.1 *S. exigua* larvae population density

The analysis of population density variance of *S. exigua* larvae on Lembah Palu shallot plants showed that the treatment of *N. oleander* leaf extract concentration had a significant effect on the population density of *S. exigua* larvae (P = 0.00). The findings of the tests carried out to evaluate the impact of the concentration of *N. oleander* leaf extract on the population density of *S. exigua* larvae in the Lambah Palu shallot plant are shown in Table 1.

Table 1. These are the findings of a study to determine the effect of a concentration of *N. oleander* leaf extract on the population density of *S. exigua* larvae on shallot plants from Lembah Palu

***S. exigua* Larvae Population Density**						
Tukey HSD[a,b]						
Treatment	N	Subset 1	2	3	4	5
P5	4	0.765				
P4	4		0.955			
P3	4			1.255		
P2	4				1.567	
P1	4				1.702	1.702
P0	4					1.845
Sig.		1.000	1.000	1.000	0.184	0.146

The effects of a concentration of *N. oleander* leaf extract on the population density of *S. exigua* larvae in the Lembah Palu shallot plant are shown in Table 1 for the treatment tests conducted on the plant.

The test results showed that the P5 treatment was significantly different from all treatments. However, between P0 and P1 treatments and between P1 and P2 treatments were not entirely different. Figure 2 depicts a population density graph of *S. exigua* larvae at various concentrations of *N. oleander* leaf extract, where the larvae were found to be abundant.

S. exigua larvae were found to be less abundant in the valley of Palu on shallots when the concentration of *N. oleander* leaf extract applied to the valley of Palu on shallots was increased. This shows that the higher the concentration of *N. oleander* extract, the lower the population density. Thus, at the concentration level P0 the population density of *S. exigua* has a high population density, while at P5, the population density is low. That is, the concentration can control the population density of *S. exigua* larvae.

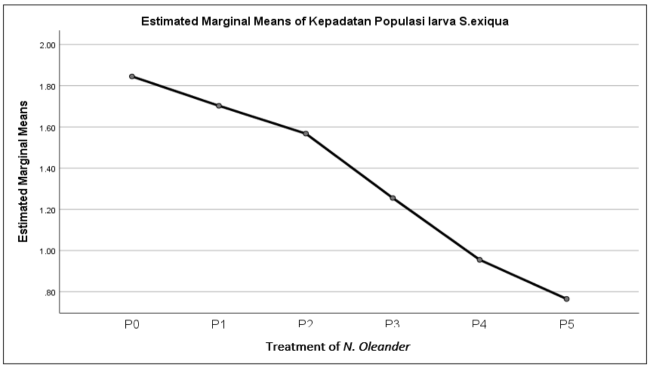
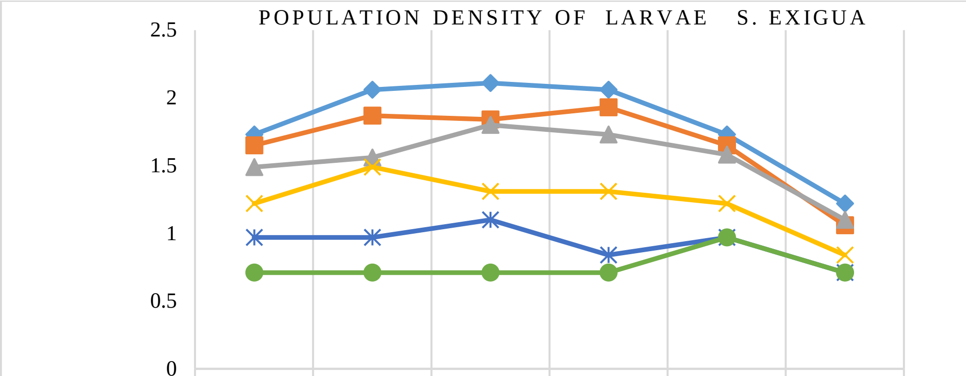


Figure 2. Population density graph of *S. exigua* larvae between the treatment of *N. oleander* leaf extract concentrations in Lembah Palu shallot plant



OBSERVATION	1	2	3	4	5	6
Sum of P0	1.73	2.06	2.11	2.06	1.73	1.22
Sum of P1	1.65	1.87	1.84	1.93	1.65	1.06
Sum of P2	1.49	1.56	1.8	1.73	1.58	1.1
Sum of P3	1.22	1.49	1.31	1.31	1.22	0.84
Sum of P4	0.97	0.97	1.1	0.84	0.97	0.71
Sum of P5	0.71	0.71	0.71	0.71	0.97	0.71

Figure 3. Graph of the population density development of *S. exigua* larvae at the concentration of *N. oleander* leaf extract in Lembah Palu shallot plant

Figure 3 shows that the highest average population density of *S. exigua* larvae in Lembah Palu shallot crop was found in the third week of observation (34 DAP), namely in the treatment P0, P2 and P4. In the P1 treatment, the population density of *S. exigua* larvae was the highest in the fourth observation (41 DAP), while in the P3 treatment, the highest population density of *S. exigua* larvae was in the second observation (27 DAP). The lowest population density of *S. exigua* larvae was found at the sixth week of the word (55 DAP).

3.2 *S. exigua* larvae attack intensity

The examination of the varied intensity assaults of *S. exigua* larvae on Lembah Palu shallots revealed that the concentration of *N. oleander* leaf extract applied to the shallots had a statistically significant influence on the intensity of the larvae's attack. (P = 0.00) Results of the tests conducted to determine the effect of different *N. oleander* leaf extract concentrations on the degree of *S. exigua* larvae attack on Lembah Palu shallots are shown in Table 2.

Table 2. The test results of the treatment of *N. oleander* leaf extract concentration on the intensity of *S. exigua* larvae attack Lembah Palu shallot plant

***S. exigua* Larvae Population Density**					
Tukey HSD[a,b]					
Treatment	N	Subset			
		1	2	3	4
P5	4	0.710			
P4	4		1.845		
P3	4			2.547	
P2	4				2.970
P1	4				1.702
P0	4				
Sig.		1.000	1.000	1.000	1.000

Table 2 showed the test results of the treatment of *N. oleander* leaf extract concentration on the intensity of *S. exigua* larvae attack Lembah Palu shallot plant. It showed that the P5 treatment was significantly different from all treatments. However, P0 and P1 treatments were not considerably other. Graph of *S. exigua* larvae attack intensity on Lembah Palu shallot is shown in Figure 3.

S. exigua larvae assault on the shallot plant are reduced in intensity when a greater concentration of *N. oleander* leaf extract is given to the shallot plant, as seen in Figure 4.

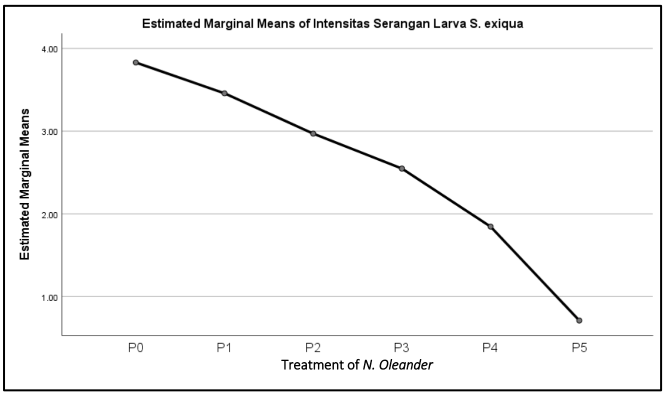
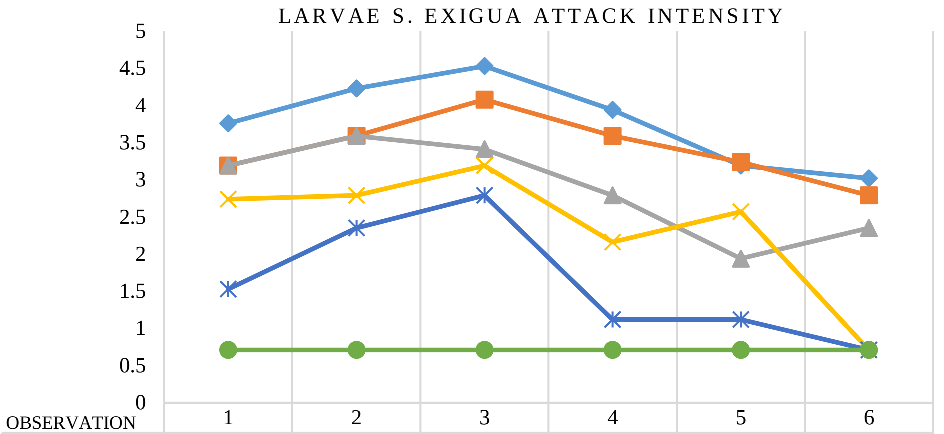


Figure 4. Graph of *S. exigua* larvae attack intensity on the concentration of *N. oleander* leaf extract in Lembah Palu shallot plant

Figure 5 shows that the highest average attack intensity of *S. exigua* larvae on Lembah Palu shallot was found in the treatment P0 of the third week of observation (34 DAP). The lowest intensity of *S. exigua* larvae attack was found in treatment P3, P4 and P5 of the sixth week of the word (55 DAP).

3.3 Shallot production

The concentration of *N. oleander* leaf extract had a substantial influence on the production of shallots of the Lembah Palu variety, according to the results of an investigation into shallot production (P = 0.00).



OBSERVATION	1	2	3	4	5	6
Sum of P0	3.76	4.23	4.53	3.94	3.19	3.02
Sum of P1	3.19	3.59	4.08	3.59	3.24	2.79
Sum of P2	3.19	3.59	3.41	2.79	1.94	2.35
Sum of P3	2.74	2.79	3.19	2.16	2.57	0.71
Sum of P4	1.53	2.35	2.79	1.12	1.12	0.71
Sum of P5	0.71	0.71	0.71	0.71	0.71	0.71

Figure 5. Graph of *S. exigua* larvae attack intensity development at the concentration of *N. oleander* leaf extract in Lembah Palu shallot plant

Table 3 shows the results of Lembah Palu shallot production with *N. oleander* leaf extract treatments with several concentrations. It shows that at the average, the treatments were in the same subset. They were not significantly different, but they were quite different between different subsets.

Table 3. The results of Lembah Palu shallot production with *N. oleander* leaf extract treatments with several concentrations

Production of shallot bulbs					
Tukey HSD[a,b]					
Treatment	N	Subset 1	2	3	4
P0	4	5.137			
P1	4	6.042	6.042		
P2	4	6.412	6.412	6.412	
P3	4		7.297	7.297	7.297
P4	4			7.472	7.472
P5	4				8.507
Sig.		0.054	0.060	0.142	0.073

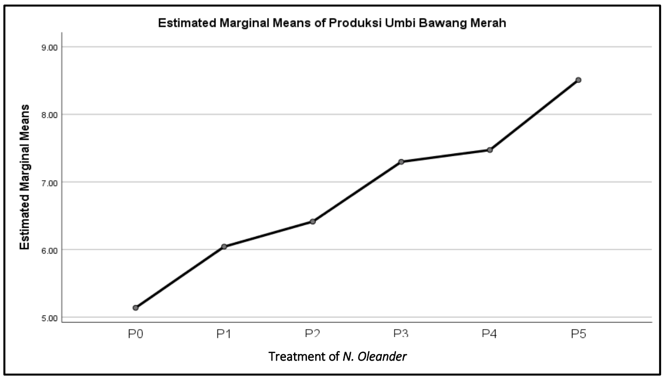


Figure 6. Graph of Lembah Palu shallot production in the treatment of *N. oleander* leaf extract with several concentration

Figure 6 shows that the highest shallot production was found in treatment P5 with a production of 8.51 tons/ha and the lowest was in treatment P0 with a production of 5.14 tons/ha.

4. DISCUSSION

4.1 *S. exigua* larvae population density

It is possible to protect the Lembah Palu shallot plant against attack by *S. exigua* larvae by using a high concentration of *N. oleander* leaf extract applied to the plant's leaves. It is possible to regulate the population density of *S. exigua* larvae in a controlled environment. According to the results of the study on the capacity of *N. oleander* leaf extract to regulate *S. exigua* larvae in the Lembah Palu shallot plant, the concentration of *N. oleander* leaf extract has an effect on the population density of *S. exigua* larvae in the Lembah Palu shallot plant. This occurs because the active components in *N. oleander* leaf extract include oleandrin chemicals, which are poisonous to insects and are used as insecticides [30, 31].

More *N. oleander* leaf extract is given to the Lembah Palu shallot plant the greater the concentration of the extract, the lower the average population density of *S. exigua* larvae. This is because *N. oleander* contains an active ingredient of glycosides in the form of oleandrin compounds to control the development of the population density of *S. exigua* larvae. It also has flavonoid phytochemical compounds [32] containing polyphenols which are effective as insecticides [33] to reduce population density.

4.2 The attack intensity of *S. exigua* larvae

The highest attack intensity of *S. exigua* larvae in the Lembah Palu shallot plant was found in the P0 treatment, namely the treatment without the application of *N. oleander* leaf extract, in the third observation when the plants were 34 days old.

The application of *N. oleander* leaf extract to the Lembah Palu shallot plant can reduce the severity of the *S. exigua* larval assault, and the amount of reduction is proportional to the concentration of *N. oleander* leaf extract applied to the shallot plant. The amount of reduction is proportional to the concentration of *N. oleander* leaf extract applied to the shallot plant. A greater attack intensity by *S. exigua* larvae was observed at the P1 attention stage when compared to a shallot plant with a higher content of *N. oleander* leaf extract. As a result, the greater the concentration of *N. oleander* leaf extract applied to the Lembah Palu shallot plant, the lower the severity of *S. exigua* larval assault on the shallot plant was. Due to the fact that the greater concentration of *N. oleander leaf* extract has a larger concentration of the active component of *N. oleander*, which is poisonous and causes the intensity of *S. exigua* larval assaults to diminish, the higher concentration of *N. oleander* leaf extract is beneficial. *N. oleander* has a lethal impact on insects and is an excellent larvicide [32, 34].

4.3 Shallot production

The application of *N. oleander* leaf extract on the Lembah Palu shallot plant can protect the plant during the growing season to save its production. In the treatment without the application of *N. oleander* leaf extract, the attack of *S. exigua* larvae was seen in the first observation of 13.75% and the percentage of attacks continued to increase until it reached the highest attack in the third observation of 20%. In the following observation period, the invasion of *S. exigua* larvae decreased until the end of the statement. In this treatment, even though Lembah Palu shallot plants did not get protection from the application of *N. oleander* leaf extract, the shallot plants could still survive and gave a production of 5.14 ton/Ha.

Lembah Palu shallot production without the application of *N. oleander* leaf extract of 5.14 tons/ha resulted from Lembah Palu shallot plant withstanding the attack of *S. exigua* larvae. The shallot plant ability to survive was due to a sound maintenance system, namely the provision of NPK additional fertilizers, watering the plants every day in the afternoon, cleaning the weeds by pulling out weeds that grow around the plants and then burying the weeds back into the soil around the plants. Weed removal is an effort to sanitize the land with weed management [35], so that the plants can absorb nutrients.

Shouldot plant production rose as the concentration of *N. oleander* leaf extract applied to the plant increased in the treatment of the concentration of *N. oleander* leaf extract applied to the plant, as shown in the graph below. The increasing concentration of *N. oleander* extract makes the active ingredients more toxic to protect the shallot plants from *S. exigua* larvae attack. Apart from the fact that *N. oleander* leaf extract contains toxic oleandrin compounds, the application of good agricultural practices by applying healthy plant cultivation and regular observation as part of the principles of integrated pest management can reduce the use of pesticides [36]. This application resulted in the production (tuber weight) of Lembah Palu shallots reaching the highest production of 8.51 tons/ha in treatment P5 and the lowest production at treatment P0 of 5.14 tons/ha.

The application of *N. oleander* leaf extract, which is effective in controlling *S. exigua* larvae is the P3 treatment (10.75 g/Ha). Given the need for one hectare, P3 treatment only requires 4.3 l/ha with a production of 7.29 tons/ha compared to the use of P4 treatment of *N. oleander* leaf extract of 8.6 l/ha with the production of 7.47 tons/ha and P5 of 17.2 l/ha with the production of 8.51 tons/Ha.

5. CONCLUSION

In the case of the Lembah Palu shallot plant, the application of *N. oleander* leaf extract can help to reduce the population density and severity of *S. exigua* larval assault, as well as enhance the amount of Lembah Palu shallot produced. More *N. oleander* leaf extract was used in the experiment, which resulted in reduced population density and attack intensity of *S. exigua* larvae, as well as increased Lembah Palu shallot output. An effective weed control method for the merah lembah palu tanaman is the use of consentrasi weed control for the *N. oleander* P3 (10.75 g/Ha) with a production rate of 7.29 tons per hectare (ton/ha).

ACKNOWLEDGMENT

The authors express gratitude to the International Publication & Collaborative Center (IPCC) Team of Tadulako University for their assistance in completing this journal and the students of the Faculty of Agriculture Tadulako University for their support in collecting the field data.

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