The effect of application of control techniques to the population, damage intensity of onion caterpillar (*Spodoptera exigua* hubner) and yield of shallots

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Abstract. Shallot is an important cash crop in Indonesia. However, its productivity is relatively low, due to the attack of the onion caterpillar (*Spodoptera exigua* Hubner). This study aimed to identify the effect of the application of control techniques on the population, damage intensity, and shallots yield. This research was conducted by field experiment. Control treatment consisted of covering shallots by using gauze/net and insecticide treatment with active ingredients of profenofos, metomil, and carbosulfan. The research variables consisted of the population and the damage intensity of *S. exigua*, as well as the yield of shallots. The results showed that the caterpillars population of *S. exigua* was found at 16 DAP and increased up to before harvest at 44 DAP. Covering shallots with gauze effectively suppressed the population of *S. exigua* (0.0 per hills), followed by treatment with profenofos (0.14 per hills), carbosulfan (0.15 per hills), and methomyl 0.32 per hills). The damage intensity of *S. exigua* in the plot gauze covered was 0%, lower than 32%, 25%, 12%, 10%, respectively, in the control plot, treatment of metomil, carbosulfan, and profenofos. Covering shallots with gauze also increased the weight of wet-harvested tubers (50.83 g per hills).

1. Introduction
Shallots (*Allium ascalonicum*, L) is one of the important horticultural commodities in lowland land in Indonesia [1], so it has the potential to be developed as a farming business [2]. Shallot production in Indonesia, e.g. 2019 was 1,580.24 tons with a growth value of 5.11 over a period of 4 years [3], lower than the shallot-producing countries i.e. Egypt, which was approximately 3 million tons [4]. One of the obstacles to increasing shallot productivity in Indonesia is the attack of pests, i.e. onion caterpillars (*Spodoptera exigua* Hubner) (Lepidoptera: Noctuidae) [5,6]. The caterpillar damages the leaves by burrowing from the inside of the leaf. Damage to shallots is characterized by white leaf spots on the tips/parts of the leaves, or leaves become membranous and wilt [5]. According to Soumia et al. [7] *S. exigua* caused about 44.72% low damage and an increase of 81.90% before harvest, which caused damage to 10-12% of shallot bulbs, so control is needed, to prevent higher damage [8].

The population of *S. exigua* is found in every growing season, but the highest attack is recorded in the dry growing season [8,9], so that the application of pesticides is the method most widely used by farmers. However, the intensive use of pesticides has the potential to pollute the environment and...
pesticide residues in shallot products. The use of pesticides also causes a decrease or even loss of non-target insects i.e. parasitoids, predators, and other useful insects, which causes a decrease in population and faunal diversity, resurgence of pest populations, and development of pesticide-resistance [10,11].

To minimize these impacts, more environmentally friendly pest control techniques are needed. Mechanical pest control techniques i.e. covering with gauze/net can be used as an alternative control to suppress the population of eggs and larvae of *S. exigua* and the intensity of damage to shallots. The use of screen houses was able to reduce the population and damage to cabbage plants by cabbage head caterpillars and reduce the number of insecticide applications by 62.50% [12]. Therefore, this study aimed to determine the effect of covering with gauze/net on shallot plants on population, intensity of attack of *S. exigua*, and yield of shallots. The presence of natural enemies, especially parasitoid insects and predators in the shallot ecosystem was also observed in this study.

2. Materials and method

2.1. Research site and material

This research was conducted in Wanasari-Brebes, Central Java-Indonesia, which is 3.0 meters from sea level at a position of 6° 44'-7° 2' South and 108° 41'- 109° 11' East. Humidity (RH) 73% and average temperature 35°. Research in the rainy season (October-December 2020). The variety of shallots was Bima-Brebes, while the active ingredients of the insecticide applied were Profenofos, Carbosulfan, and Metomil. This study was designed as a field experiment with control treatments i.e. plots of Profenofos insecticide application, Metomil insecticide application, Carbosulfan insecticide application, and mechanical control with gauze/net, and control plot (check). Insecticide application was adopted according to farmer practice, i.e. concentrations of 3 ml/l, 4 g/l, and 11 g/l with application doses of 2.5 l/ha, 3.3 kg/ha, and 9.2 kg/ha for Profenophos, Metomil, and Carbosulfan, respectively. Treatment of covering shallots using gauze size 7.0 mesh.

2.2. Research variable

Populations of eggs, larvae, pupae, and imago of *S. exigua* were recorded directly by visual observation on the three hills per sample unit. Thirty sample units were randomly selected for each treatment. The observation interval was five days from plants aged two weeks after planting to one week before harvesting by using a zig-zag, according to the method of Harahap et al. [13] and Kementerian Pertanian [14]. Observation was carried out at 07.30-11.00 AM. Damage intensity of *S. exigua* was recorded based on the number of leaves attacked directly by visual observation on a sample unit of 3 three hills. Thirty sample units were randomly selected for each treatment. The observation interval was five days, starting from two weeks after planting to one week before harvesting in a zigzag pattern, according to the method of Harahap et al. [13] and Kementerian Pertanian [14].

The kinds of predators were recorded directly in the unit sample of shallots by using insect nets. Fifteen double swings were selected randomly for each treatment [15]. The observation was carried out at 07.30-11.00 AM. Meanwhile, the observation of the percentage of its parasitization was carried out by collecting eggs and larvae on shallots aged 20 days after planting. Live eggs and larvae were collected in individual plastic bottles. Samples of eggs and larvae collected from the field were kept alive in the laboratory until parasitoid insects or the next stage emerge [16]. The kinds of predators and parasitoids were found preserved in 70% alcohol for identification [17].

The average population of eggs, larvae, and imago of *S. exigua* was calculated by the formula of Paparang [18], as follows: \( P = \frac{mn}{N} \times 100 \), \( P = \) Population of *S. Exigua*, \( n = \) Number of larvae found per unit sample, and \( N = \) Number of samples observed. The same formula was used to calculate the damage intensity of *S. exigua* and percentage of parasitism, by modifying the recorded aspect. The wet weight of the stover was calculated by weighing each sample clump after harvest using a balance. A simple linear regression test was also performed to identify the relationship between the larval population and the damage intensity of shallots. The anova test was carried out to determine the differences between
3. Results and discussion

3.1. Population of S. exigua
The population of S. exigua in shallot was found at 16 DAP. Population growth increased in line with the age of the plant and the peak of population occurred at 44 DAP (before harvest). The highest population was recorded in the control plot and the lowest in the gauze covering treatment (Figure 1). These results are in line with Marsadi et al. [21] which also recorded populations of S. exigua larvae on shallots found until the end of the growing season. In the early population (plants stage 17 and 21 DAP), the average larval population was 0.01 per hills, but the population tends to increase and the peak population of S. exigua larvae was recorded in shallot plants at 45 DAP with an average larval population of 2.4 per hills. The population of S. exigua larvae in the rainy season planting tends to be lower than in the dry season planting [8].

![Figure 1. Population growth of Spodoptera exigua larvae in several control treatments.](image1)

The population of S. exigua larvae was not found in the shallots covered by using gauze, but was found in the insecticide treatment plot and also the control plot. The highest average population 0.62 per hills was found in the control plot, followed by 0.32 per hills in the metomil insecticide plot, 0.15 per hills in the carbosulfan plot, and 0.14 per hills in the profenofos treatment plot (Figure 2). This study showed that the covering of shallots with gauze was more effective in suppressing the population of shallot caterpillar larvae than the application of insecticides. In addition, the onion caterpillar of S. exigua in the study area has also been indicated to be resistant to the insecticides [6,22]. The practice of applying insecticides by mixing 2-5 types of insecticides in one spray and a frequency of 2-3 times per week will have a risk of developing insect resistance [22].

![Figure 2. Average population of Spodoptera exigua larvae in several control treatments.](image2)

The average population of S. exigua larvae is affected by the growing season of shallots. In the dry season the population of S. exigua larvae can be 78 times higher than the population in the rainy season [8]. Eggs of S. exigua may fall from the leaves and fail to hatch larvae if it rains during egg laying [23].
The relatively high wind speed during the study, may also affect the moth population and the eggs laid of *S. exigua*. This aspect may cause the population of adult moths and eggs to be very low/not found in this study. Unfortunately wind speed and duration were not observed in this study. This is confirmed by Sari *et al*. research [17] that the presence of flying activity of *S. exigua* moths in shallot fields is influenced by environmental factors i.e. temperature, wind direction, rain, and moonlight.

### 3.2. Damage intensity of *S. exigua*

The results of the regression analysis showed that the population of *S. exigua* larvae had a significant effect on the intensity of onion caterpillar attacks. An increase in the population of *S. exigua* larvae will be followed by an increase in the intensity of damage to shallots (Figure 3).

![Figure 3](image-url)

*Figure 3.* Relationship between larval population of *Spodoptera exigua* and damage intensity on shallots (*Y= a+bx y=0.023+0.535 R^2 = 0.967 F=629.682 t=26.117)*.

The results of this study showed that the average damage intensity of *S. exigua* between control treatments showed a significant difference (Figure 4). Based on the results of the Tukey test (HSD), the damage intensity in the treatment of shallots with gauze coverage was significantly different from the insecticide application treatment as well as on the control plot. The highest damage intensity *S. exigua* on shallots (32%) was recorded in the control plot, followed by insecticide treatments methomyl 25%, carbosulfan 12% and profenofos 10%. The intensity of damage was not recorded in shallots by the gauze-covered treatment. Covering the shallots with gauze inhibited egg laying by *S. exigua* imago, so that no eggs and larvae were found in this treatment, and thus no damage-intensity was recorded. These results are similar to Kurniawati [24] that the use of gauze was effective in suppressing the damage of shallots.

![Figure 4](image-url)

*Figure 4.* The effect control treatments of *Spodoptera exigua* to the damage intensity of shallots.

### 3.3. Kinds of predatory insects and parasitoids

This study did not find parasitoid insects in the eggs and larvae of *S. exigua*. These results were similar to those recorded Nusyirwan [16] who also did not find egg and larval parasitoids of *S. exigua* in shallots. Several kinds of predatory insects found in shallots were common predators, such as spiders (Arachnida: Lycosidae), dragonflies (Hymenoptera: Odonata), bees (Hymenoptera: Vespidae), Coccinella beetles.
(Coleoptera: Coccinellidae), ants (Hymenoptera: Formicidae), and praying mantis (Mantodea: Mantidae).

3.4. Yield of harvesting shallots bulbs

This study noted that there was a significant effect of control treatment on the weight of yield of harvesting shallots bulbs. The average shallots bulbs treated with gauze-covered was 50.83 g per hills, higher than application of profenofos insecticide (45.41 g per hills), carbosulfan (44.13 g per hills, metomil (43.54 g per hills), and control (40.8 g per hills) (Figure 5). It is not clear why the gauze-covering treatment affected the yield of shallots bulbs. Unfortunately, this study did not observe the parameters of plant growth, even though the number of leaves and the rate of plant growth will affect the weight of the bulbs yield [25,26].

![Figure 5](image-url)  
Figure 5. The effect control treatments of *Spodoptera exigua* to the harvesting shallots bulbs.

4. Conclusion

The control technique of *S. exigua* by using gauze covered effectively to suppress the population of eggs and larvae as well as the damage intensity of *S. exigua* than an application of insecticides with active ingredients, i.e profenofos, methomyl, and carbosulfan. The average onion bulb in the gauze treatment was 50.83 g per hills, higher than the application of profenofos insecticides (45.41 g per hills), carbosulfan (44.13 g per hills), methomyl (43.54 g per hills). The study recorded that no parasitoid of eggs and larvae of *S. exigua* was found, while the predators found were common predators of the orders of Diptera, Orthoptera, Coleoptera and spiders.

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