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The Effect of Feed from the Brassicaceae Family on the Life Cycle of *Spodoptera litura*

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Abstract

Background: *S. litura* has a wide host range, so it has the potential to become a pest on various types of plants, including food crops, horticulture, and plantations. The quality and quantity of food determine the nutritional needs of insects, so they greatly influence their growth and length of development. This research aimed to determine the life cycle length, body length, pupa weight, fecundity, and prevalence of *S. litura* in several natural foods from the same plant family. **Method:** This study used non-factorial RAL with five treatment levels and was repeated 7 times. **Results:** The feed that survived to the imago stage was cauliflower, green and white mustard greens, and produced eggs. The fastest life cycle for cauliflower feed is 24 days, green mustard greens are 30 days, and white mustard greens are 25 days. The eggs that successfully hatched were in the Sh and Sp treatments, with Sh with 12% egg fertility and Sp 74%. **Conclusion:** The different types of 5 different feeds show different growth and development results for *S. litura* depending on the amount and content of the feed itself.

Keywords: Life cycle; *Spodoptera litura*; Type of feed

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Introduction

Spodoptera litura (Fabricius) (Lepidoptera: Noctuidae) is a phytophagous insect that can eat the leaves and pods of vegetables. This insect has a wide host distribution because it is polyphagous. *S. litura* has many host plants, including soybeans, beans, chilies, cabbage, mustard greens, and plantation crops such as cotton and tobacco. According to (Budi, 2013), *S. litura* has a wide host range, so that it can become a pest on various types of plants, including food crops, horticulture, and plantations. This pest attack can cause damage to cabbage plants by up to 80-100%, which causes farmers to suffer significant losses. Therefore, it is necessary to conduct a more in-depth study of the nature of life and several aspects of the biology of this insect. The development of the life cycle of *S. litura* is greatly influenced by the feed consumed. The type of feed can also affect growth, such as body length and pupa weight, as well as insect development, fecundity, perianth, and life cycle. According to (Wandansari et al., 2022), feed is the primary energy source for growth and development. According to (Sudrajat et al., 2020), the nutritional needs of insects are determined by the quality and quantity of feed, so it significantly affects the growth, development, and duration of insect development. Insects will identify plants that will be used as host plants for oviposition (Li et al., 2020), look for food sources (Sugimoto et al., 2023), and the location of partners for copulation (Xu and Turlings, 2018). Insect acceptance and rejection of feed are determined by the presence of chemical compounds in the feed or feed that is not fresh. The sensor for selecting plants as plants to be consumed is in the primary olfactory receptors of insects in the antennae. Insect antennas contain several protein types that detect odor molecules (Da-Silva et al., 2019). Plants often have several secondary metabolites for defense against insects, and different plants can have different phytochemical sequences. Glucosinolates are one of the largest groups of secondary metabolites that are toxic to insects, and more than 120 similar glucosinolates have been found in members of the Brassicaceae family, including B. juncea, Brassica oleracea, and Brassica rapa (Hopkins et al., 2009). The feed used for this study was from Brassicaceae family plants including cabbage, cauliflower, broccoli, and green and white mustard greens. Previous studies have conducted a lot of research on rearing *S. litura* with artificial feed as an alternative feed that already has nutritional content according to the needs of *S. litura*. The selection of feed from the Brassica family because *S. litura* is an insect pest on cabbage and mustard greens, and *S. litura* has polyphagous properties. Thus, this study aimed to determine the effect of feed from the Brassica family on the life cycle length, body length, pupal weight, fecundity, and perianth of *S. litura* on several natural feeds from the same plant family.

Methods

This research was conducted in March-May 2024 at the Plant Health Laboratory 2, Faculty of Agriculture, National Development University "Veteran" East Java. This study used a non-factorial, Completely Randomized Design (CRD) method with five treatment levels and repeated 7 times for each treatment so that there were 35 experimental plastic containers. Each container was infested with 1 *S. litura* larva instar one and fed 5 g/container.

Provision of Feed and Test Insects

Organic vegetable feed was obtained from the Twelve's Organic Garden in Pacet, Mojokerto Regency and the Abang Sayur Organic Garden in Batu, Malang Regency. *S. litura* was fed at the larval stage, weighing 5 g/container, and was replaced daily. At the imago stage, it was fed with a diluted honey solution. Test insects were obtained from BSIP-TAS (Center for Standard Testing of Sweetener and Fiber Plant Instruments), Malang Regency. Test insects were treated from the instar 1 phase and maintained until they became imago and died.

Procedure

This study consisted of 5 treatment levels: cabbage, cauliflower, broccoli, green mustard greens, and white mustard greens. Each treatment was repeated 7 times to obtain 35 experimental containers. Each experimental container was infested with one larva at the 1st instar stage and given 5g of feed. The 1st instar larvae were placed in a 350 ml plastic container for the larval phase and a 5 ml plastic container for the imago. The feed was changed every day, and then, when the larvae entered the 6th instar stage, their body weight was weighed. The pupae were identified by sex and transferred to a 5 l jar, given 2 cm of cocopeat and tissue as a place to lay eggs, and maintained in imago. Pupae identified by sex were transferred to a 5 l container. After the pupae entered the imago phase, they were given honey liquid feed diluted with a concentration of 10%. According to Wahyuni (2023), the imago feed for *S. litura* used a 10% concentration of honey solution at the top of the plastic container. Eggs that are successfully spawned will be counted and moved to another container, and their development will be observed.

Data Analysis

The observation parameters in this study were the body length of *S. litura* at each stage, the weight of instar six and pupae, sex ratio, fecundity, peridiality, and egg fertility. Egg fertility can be calculated using the formula:

Egg Fertility = (Number of eggs hatched) / (Total number of eggs) x 100%

The research data were analyzed statistically using Analysis of Variance (ANOVA) to determine whether each treatment had an effect. Further testing was conducted using Duncan's Multiple Range Test (DMRT) at the 5% level if the therapy significantly impacted.

Result

Life Cycle Length of S. litura

S. litura is an insect that undergoes complete metamorphosis (holometabola) starting from eggs, larvae, pupae, and imago. Growth is the increase in physical size and body structure of *S. litura* towards the final stage. Development is the quality of *S. litura* in surviving and reproducing. The growth and development of *S. litura* are influenced by the amount and type of feed consumed. The results of observations of the life cycle length of *S. litura* in several treatments of feed types from the Brassicaceae family can be seen in (Table 1).

Table 1. Life cycle of S. litura

Stadia	Mean Life Cycle Length (days) ± SD				
	Ku	Bk	Br	Sh	Sp
Instar 1	3.00 ± 0.00 a	2.00 ± 0.00 a	2.00 ± 0.00 a	2.00 ± 0.00 a	2.00 ± 0.00 a
Instar 2	4.60 ± 5.40 c	2.00 ± 0.00 b	2.00 ± 0.00 b	1.00 ± 0.00 a	1.00 ± 0.00 a
Instar 3	7.40 ± 0.54 c	2.00 ± 0.00 b	2.00 ± 0.00 b	1.00 ± 0.00 a	1.00 ± 0.00 a
Instar 4	4.20 ± 3.83 b	2.00 ± 0.00 ab	2.00 ± 0.00 ab	2.00 ± 0.00 a	1.00 ± 0.00 ab
Instar 5	6.00 ± 5.47 b	2.00 ± 0.00 a	2.00 ± 0.00 a	1.00 ± 0.00 a	1.00 ± 0.00 a
Instar 6	0.00 ± 0.00 a	2.00 ± 0.00 a	1.80 ± 1.64 ab	1.20 ± 1.09 b	1.20 ± 1.09 b
Prepupa	0.00 ± 0.00 a	3.20 ± 1.78 b	0.60 ± 1.34 a	1.60 ± 1.51 ab	1.80 ± 1.64 ab
Pupa	0.00 ± 0.00 a	6.00 ± 3.46 c	0.00 ± 0.00 a	7.00 ± 3.93 bc	5.40 ± 4.97 bc
Imago	0.00 ± 0.00 a	3.00 ± 6.70 ab	0.00 ± 0.00 a	13.3 ± 7.46 c	8.20 ± 7.56 b
Total	26 Days	24 Days	14 Days	30 Days	25 Days

Note: The average followed by the same a, b, and c notation letters shows no significant difference in the Duncan's Multiple Range Test (DMRT) at a 5% level.

The results of observations on the life cycle of *S. litura* when fed cauliflower (Bk) showed the fastest results compared to other treatments. The green mustard (Sh) feed treatment showed that the larval phase stages were not significantly different from the white mustard (Sp) feed treatment. The cabbage (Ku) and broccoli (Br) treatments showed the slowest treatments. According to (Azwan, 2020), there is a tendency that the more feed consumed, the shorter the life cycle will be, meaning that the more sufficient the feed, the faster the insect will experience a life cycle. The average life cycle of *S. litura* generally lasts 30-38 days. The study's average cycle length on mustard greens (Wahyuni et al., 2023) lasted 30 days.

The results of observations show different cycle lengths for each treatment. The results of observations on the cabbage (Ku) treatment only lasted until the 5th instar stage and died. The alleged death of *S. litura* was due to insect rejection in choosing food because cabbage feed has a thick leaf morphology, so instar larvae 1-3 have difficulty consuming food. Larvae only eat ± 1-2 g of the feed provided. The amount of feed consumed is getting smaller. It will inhibit the development of larvae to the next stage, so the treatment (Ku) takes 24 days to instar five and then dies.

The broccoli (Br) observation showed that larvae survived the pupal stage and did not become imago. Pupae were declared dead if there were no signs of life when nudged. Pupae death is suspected due to the small amount of feed consumed during larval. Larvae only ate ± 3 g of the feed provided. As a result, the pupae only survived for 2 days and did not survive to the final stage.

The treatment of cauliflower feed (Bk), green mustard (Sh), and white mustard (Sp) showed good development of *S. litura* until the final stage. Cauliflower (Bk) feeding lasted for 24 days, green mustard feeding for 30 days, and white mustard feeding for 25 days. These three treatments consumed 5 g of feed given during instars 3-5; there was a decrease in the amount of feed during instar six because it experienced prepupa. According to the study's results (Azwan et al., 2020) the more feed eaten, the more it helps shorten the life cycle of *S. litura* in regulating growth and insect reproduction. Supported by the study's results (Hidayati & Asri, 2019), the fulfillment of feed nutrition affects the growth and development of *S. litura*; protein is the nutrient most needed to accelerate towards the final instar. Cabbage plants (Ku) contain 1.7 g of protein; broccoli plants (Br) contain 2.82 g of protein (USDA, 2016); cauliflower plants (Bk) contain 4 g of protein (Kindo & Signh, 2018); green mustard plants (Sh) and white mustard plants (Sp) contain 1.8 g of protein. Observation results showed that the cauliflower (Bk) treatment was successful until the imago stage was the fastest, which was 24 days, followed by the white mustard (Sp) treatment for 25 days and green mustard (Sh) for 30 days. The protein content of mustard is lower than that of broccoli feed, but the amount of feed consumed by the larvae is greater, so it helps the larvae reach the final instar in good condition.

Body Length, Weight of Instar 6 Larvae & Pupae of S. litura

The growth of the body length of *S. litura* is influenced by the amount and type of feed consumed. The greater the amount of feed consumed, the more significant the increase in the larvae's body length and body weight, which will later affect the weight and length of the pupa. The results of observations of the body length of *S. litura* in several treatments of feed types from the Brassicaceae family can be seen in (Table 2).

Table 2. *S. litura* Body length (cm) ± SD

Stadia	Body length (cm) ± SD				
	Ku	Bk	Br	Sh	Sp
Instar 1	0.20 ± 0.00 a	0.20 ± 0.00 a	0.20 ± 0.00 a	0.20 ± 0.00 a	0.20 ± 0.00 a
Instar 2	0.64 ± 0.25 a	0.62 ± 0.13 a	0.64 ± 1.14 a	0.60 ± 1.00 a	0.82 ± 1.30 b
Instar 3	0.82 ± 0.14 a	1.00 ± 0.07 a	1.10 ± 1.41 ab	1.26 ± 2.07 ab	1.30 ± 3.24 b
Instar 4	0.98 ± 0.76 a	1.34 ± 2.40 a	1.54 ± 2.38 a	2.18 ± 2.77 a	2.08 ± 8.25 a
Instar 5	1.50 ± 1.14 ab	2.00 ± 1.80 a	1.90 ± 1.158 a	3.84 ± 4.87 b	2.50 ± 8.27 ab
Instar 6	0.00 ± 0.00 a	2.74 ± 2.30 a	2.64 ± 3.91 a	3.10 ± 4.47 a	3.58 ± 2.49 b
Pupa	0.00 ± 0.00 a	1.26 ± 0.70 a	0.00 ± 0.00 a	0.92 ± 5.54 a	0.86 ± 7.89 a
Imago	0.00 ± 0.00 a	0.80 ± 3.57 a	0.00 ± 0.00 a	0.80 ± 4.47 a	0.60 ± 5.47 a

Note: The average followed by the same letter notation a, b, c shows no significant difference in the Duncan's Multiple Range Test (DMRT) at 5% level.

The observation results show that differences in feed types result in a delay in the growth of the body length of the larvae. The growth of the length of the larvae from instar 1 to instar 2 is quite constant in all treatments. The best body length development is in the cauliflower (Bk), green mustard (Sh), and white mustard (Sp) feed treatments, followed by broccoli (Br), and cabbage (Ku), which are the least. The average length of instars 2 and 3 is 1-1.5 cm, but it is still less than 1 cm in the cabbage treatment. The best length of instar 4 larvae is in the white mustard (Sp) and green mustard (SH) treatments, then cauliflower (Bk) and broccoli (Br) with an average of 1.5 cm while the average is 1.2 cm. The average length of the pupa is 1 cm. The difference in body length between larvae and pupae is due to the different amounts of feed consumed by insects.

Table 3. Weight of 6th instar larvae and pupae of *S. litura*

Stadia	Body weight (g) ± SD				
	Ku	Bk	Br	Sh	Sp
Instar 6	0.00 ± 0.00 a	0.67 ± 0.30 a	0.20 ± 0.00 a	0.52 ± 0.00 a	0.44 ± 0.00 a
Pupa	0.00 ± 0.00 a	0.27 ± 0.13 a	0.10 ± 1.14 a	0.22 ± 1.00 a	0.15 ± 1.30 b

Note: The average followed by the same a, b, and c notation letters shows no significant difference in the Duncan's Multiple Range Test (DMRT) at a 5% level.

The results of observations of the weight of instar six larvae in the cauliflower (Bk) treatment showed the heaviest compared to broccoli (Br), green mustard (Sh), and white mustard (Sp) larvae. The weight of instar six larvae will affect the weight of the pupa. Under the results of further tests, the cauliflower (Bk) treatment showed the heaviest pupa and broccoli (Br) the lightest.

Pupae in the broccoli (Br) treatment that did not turn into imago showed no signs of life when held, and the weight of the pupa would be lighter than before. Unbalanced nutrition with optimal growth and development influenced pupae that failed to become imago. Pupae can be said to have failed to become imago if the pupae do not show signs of life when touched. According to (Azwan, 2020), the more *S. litura* likes the feed consumed, the more it will increase the potential for pupae to become imago in a shorter time successfully. The duration of the prepupa and pupa stages shows that the more sufficient the food consumed, the shorter the life of the prepupa.

Table 4. Sex ratio of *S. litura*

Treatment	Number of Imago (tail)	
	Male	Female
Ku	0	0
Bk	0	0
Br	232	0
Sh	1.945	233
Sp	2.270	1.671

The observation results show the influence of the amount of feed factor on the sex ratio of insects, causing the potential number of female insects to increase; if the feed is insufficient, the male sex will be produced. The results of the sex ratio observation in cycle 1 of the Ku treatment did not obtain imago because the larvae stopped developing at the 5th instar stage. The Bk treatment obtained one female imago. The Br feed treatment did not get an imago because the pupa failed to become an imago. The Sh feed treatment obtained three imago, including two female and one male. The Sp treatment was obtained for three imago, including one female and two male.

Fecundity and Fertility of S. litura

The results of the observation showed that three treatments were successful in becoming imago and copulation, namely cauliflower (Bk), green mustard (Sh), and white mustard (Sp). According to research (Ramaiah and Maheswari, 2018), *S. litura* can lay ± 500 eggs in 15 egg groups on tobacco plants; they copulate at night. The results of observations of green mustard (Sh) feed produced 1,945 eggs and 233 eggs hatched, the white mustard treatment produced 2,270 eggs and 1,671 eggs hatched, while the cauliflower treatment produced 232 eggs and none hatched. The following table shows the number of eggs observed in several types of feed treatments from the Brassicaceae family (Table 4).

Table 5. Results of Fertility, Fecundity, Fertility of *S. litura*.

Treatment	Periphery	Fecundity	Fertility (%)
Ku	0	0	0.00
Bk	0	0	0.00
Br	232	0	0.00
Sh	1.945	233	12.0
Sp	2.270	1.671	74.0

The results of observations of green mustard (Sh) and white mustard (Sp) treatment eggs can hatch, and egg fertility can be seen in (Table 5). Green mustard (Sh) treatment produces 12% egg fertility, and white mustard produces 74%. In the cauliflower (Bk) treatment, the eggs did not hatch. It is suspected that the eggs could not hatch because the parent *S. litura* requires a supportive environment to breed, and environmental conditions are less suitable for the wild. *S. litura* requires hotter environmental conditions and cold laboratory environmental conditions with an average temperature of 26 oC and an average humidity of 73.4%. According to (Nation, 2008) protein loss causes insects to fail to produce juvenile hormones needed for egg development.

Conclusions

Based on the study's results, it can be concluded that cauliflower, green mustard, and white mustard feed can survive until the imago phase and produce eggs. The life cycle of the cauliflower feed treatment lasted for 24 days, green mustard feed lasted for 30 days, and white mustard feed lasted for 25 days. The cabbage feed treatment only lasted until the 5th instar phase, and the broccoli feed treatment only lasted until the prepupa phase, allegedly because it has thick leaves other feeds so that *S. litura* does not like it and can shorten the life of *S. litura*. The eggs that were successfully hatched were in the Sh and Sp treatments. The fertility of Sh eggs was 12% and Sp 74%.

Declaration statement

The authors reported no potential conflict of interest.

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