

Biology of leaf eating caterpillar, *Spodoptera litura* (Fab.) infesting soybean

Bhumika Solanki¹, A.M. Bharadiya², A.M. Parmar³, T.S. Bhuvu⁴

¹Research Scholar, Dept. of Entomology, Junagadh Agricultural University, Junagadh (India)

²Associate Research Scientist, Junagadh Agricultural University, Junagadh (India)

³Research Scholar, Dept. of Entomology, Junagadh Agricultural University, Junagadh (India)

⁴Research Scholar, Dept. of Entomology, Junagadh Agricultural University, Junagadh (India)

ABSTRACT

Investigations on “biology of leaf eating caterpillar, *Spodoptera litura* (Fab.) infesting soybean” was carried out at PG laboratory, Department of Entomology, College of Agriculture, JAU, Junagadh during *kharif* 2021. For the experiment, different stages of *S. litura* viz., eggs, larvae, pupa, adult and were studied. The data on the biology of *S. litura* revealed that the number of eggs laid by a female was 216.8 ± 23.81 . As far as the hatching per cent and the incubation period is concerned, 89.20 ± 3.43 per cent and 2.63 ± 0.48 days were recorded. Period of larval instars i.e., first, second, third, fourth, fifth and sixth were 2.43 ± 0.49 , 2.40 ± 0.48 , 3.23 ± 0.61 , 2.80 ± 0.58 , 3.30 ± 0.45 and 1.93 ± 0.24 days, respectively with a total larval period of 13.23 ± 1.68 days. Pre-pupal and pupal periods were 1.20 ± 0.40 and 7.03 ± 0.65 days, respectively. Pre-oviposition, oviposition and post oviposition periods were 2.80 ± 0.74 , 3.40 ± 0.48 and 3.20 ± 0.74 days, respectively. Male and female longevity were 6.60 ± 0.48 and 8.00 ± 0.63 days, respectively. Total male and female life span were 31.40 ± 2.03 and 33.4 ± 2.15 days, respectively having 1:1.22 (Male:Female) of sex ratio.

Key words: Biology, *S. litura*, soybean and instars

1. INTRODUCTION

Soybean [*Glycine max* (L.) Merrill.] belonging to family Leguminosae, sub-family Papilionaceae, is one of the important oilseed cash crops of India. It is a unique crop with high nutritional value, thus it is also known as the “Miracle bean, Golden bean and Crop of the planet”. It provides 40% protein, well balanced in essential amino acids, 20% oil, rich in poly unsaturated fats especially Omega 6 and Omega 5 fatty acids, 6-7% total minerals, 5-6% crude fiber and 17-19% carbohydrates [2]. From the nutritional point of view, soybean contains 43.2% protein and 20.00% of edible oil and is also a good source of phosphorus and lecithin. It also contains a good amount of potassium, sulphur and vitamin E. Soybean protein is mainly rich in amino acids like leucine, methionine and threonine that the human body requires. For vegetarians, it is known as “Poor Man's Meat”.

Soybean crop having luxuriant growth with succulent leaves attracts several insect pests for feeding, oviposition and shelter. About 65 species of insects have been reported to attack soybean from cotyledon to the harvesting stage in Karnataka [10]. Among the various insect pests reported in India the leaf eating caterpillar, *S. litura* is found to be the major one [1].

Spodoptera litura, otherwise known as the tobacco cutworm or cotton leafworm, is a nocturnal moth in the family Noctuidae. *S. litura* is a serious polyphagous pest in Asia, Oceania and the Indian subcontinent. *S. litura* is an economically important polyphagous pest in India and is considered one of the major threats to the present-day intensive agriculture and changing cropping patterns worldwide, next only to *Helicoverpa armigera* (Hubner). The pest occurs in India, Pakistan, Bangladesh, Sri Lanka, South East Asia, China, Korea, Japan, Philippines, Indonesia, Australia, Pacific Islands, Hawaii and Fiji [5].

The larvae of *S. litura* start eating leaves along the midrib and proceed gradually to the margins [3]. The grownup larvae feed for a short time on a lower surface of the leaf and migrate to the ground where they feed on young seedlings of many plant varieties [13].

2. MATERIALS AND METHODS

Studies on the biology of *Spodoptera litura* (Fab.) (Lepidoptera: Noctuidae) infesting soybean [*Glycine max* (L.) Merrill] was carried out at the P.G. Research laboratory, Department of Entomology, College of Agriculture, Junagadh Agricultural University, Junagadh during *Kharif* 2021.

2.1 Preparation of stock culture of *S. litura*

To raise the initial culture of *S. litura* in the laboratory, a large number of larvae were collected from the soybean field. Field collected larvae were reared in a round galvanized tray containing fresh tender soybean leaves. Every day sufficient amount of fresh leaves of soybean were provided to *S. litura* larvae after

removing excreta and partially eaten leaves from the tray till the larvae changed to pre-pupal form. The top of the tray was covered with fine muslin cloth held and in position by a rubber band. Before the formation of the pre-pupal stage, petri plate was filled with moist soil for pupation in the soil. The pupae formed in the soil were collected and transferred to another petri plates for the emergence of the adults.

A pair of newly emerged male and female moths were confined in a glass jar and fresh leaves of soybean were provided to the moths inside the glass jar for resting and egg-laying. A small container containing cotton swabs dipped in a five per cent honey solution was placed in a rearing jar for food for the moths. The open end of the glass jar was covered with fine muslin cloth and secured in a position with help of a rubber band. The leaves were replaced with fresh ones daily and the egg masses laid on the leaves removed from the jar were collected for further study.

2.2 Observations recorded

1. Incubation period (days), Number of eggs laid by female moth and hatchability (%)
2. Egg, larval and pupal period (days)
3. Pre-oviposition, oviposition and post-oviposition period (days)
4. The average longevity of male and female moths (days)
5. Sex ratio (Male: Female)
6. Total developmental period (days)

3. RESULTS AND DISCUSSION

The result observed on biological parameters of *S. litura* during the present study is presented here.

3.1 Egg

Adult female deposited eggs in clusters of 188 to 252 eggs and were laid on the muslin cloth cover. Eggs were spherical to round in shape and were covered with whitish to pale brown scales from abdominal tip of the female. The eggs were laid in group of 2 to 3 layers of eggs. Eggs were usually white in colour. The eggs turned to light brown to black in colour prior to hatching. Oviposition usually occurred at night time in the laboratory. Hatching of eggs was observed in the early morning hours after 2 to 3 days. The incubation period lasted for 2 to 3 days with an average of 2.63 ± 0.48 days. The egg period was 3.13 days on vegetable soybean [6].

3.2 Hatching percentage

The hatching of eggs of *S. litura* varied from 84 to 93.33 per cent with an average of 89.20 ± 3.43 per cent. The hatching percentage ranged from 89.61 to 96 per cent [4] and 87.33 to 97.33 per cent (Av. 93.16 ± 4.33) on cabbage [9].

3.3 Larva

The newly hatched larva were tiny, black headed and colour varied from pale green to dark green to black. The newly hatched larva feeds gregariously on leaves and causing scratch markings on the leaves. As *S. litura* is a nocturnal insect, severe feeding occurs at night time. During its larval period the caterpillar moulted for five times and had six larval instars. The characteristics and duration of each larval instar were observed and recorded.

3.3.1 First instar

First instar larva were very small and pale green in colour with black head and small black spots on the body. Larva have black hairs on the lateral sides of body. A dark brown to black coloured spot was present just behind the head of the larva. The first instar larva lasted for 2 to 3 days having a mean period of 2.43 ± 0.49 days. Similarly, the first instar larval period lasted for about 2-3 days on castor with an average of 2.50 ± 0.71 days [11].

3.3.2 Second instar

The second instar larva appeared pale green to light yellow in colour and there were no hairs on it. It possessed lateral strips on the side of the body. First abdominal segment possessed black marking on either sides of the mid dorsal line. Larva had three pairs of true legs and five pairs of pro legs. The first and second instar larva feeds in by scraping the leaves. The duration of second instar larva ranged from 2 to 3 days with a mean period of 2.40 ± 0.48 days. Similarly, second instar larval period was about 2-3 days with an average of 2.50 ± 0.71 days in castor [11] and 2.84 ± 0.74 days on cabbage [9].

3.3.3 Third instar

The third instar larva were dark green in colour with two dorsal black spots on the first abdominal segment. Two sub-dorsal longitudinal lines run all along the length of the body of the larva. Larva had dark crescent spots on the abdominal segments, first and eighth abdominal segment possessed the largest spots. Head region had a yellowish Y shaped spot on dorsal side. The duration of third instar larva was 3 to 4 days with a mean period of 3.23 ± 0.61 days. The body of third instar larva was green in colour. The duration of third instar larva varied from 3 to 5 days with an average of 3.36 ± 0.64 days [9].

3.3.4 Fourth instar

The fourth instar larva changed their body colour from green to brown and light green on the ventral side of the body. Body possessed three longitudinal yellow stripes all along the body with two lateral and one dark and broader mid dorsal line. Black spots with small white markings appeared dorsally along the lateral lines. Third and fourth instar larva were voracious feeders and feed on leaves individually leaving mid ribs and vein only. The duration of fourth instar larva varied from 2 to 4 days with a mean period of 2.80 ± 0.58 days. Similarly, the fourth instar larva changed their colour from green to dark blue-green dorsally and pale greenish yellow ventrally with three dorsal bands. And the larval period lasted for about 2-3 days with an average of 2.50 ± 0.71 days [11].

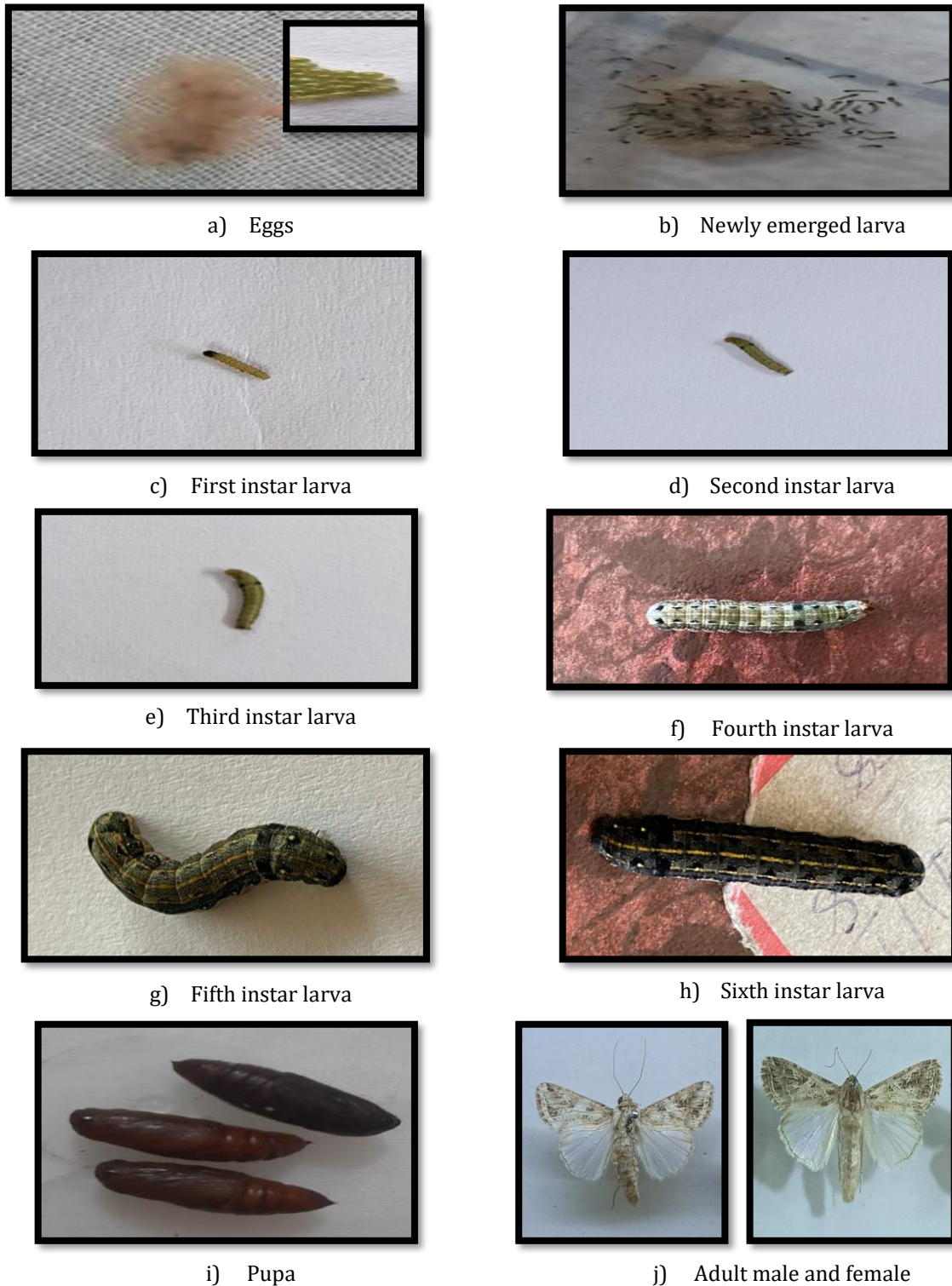


Fig. 1: Life cycle of *S. litura*

3.3.5 Fifth instar

Larval colour changed to brown to black and became fully active and voracious feeders leaving veins

and mid ribs only due to continuous feeding. The longitudinal stripes were more pronounced and distinct. Spots on the first and eighth abdominal segments were larger than others, this created a colour variation in larva with light brown colour in the dorsal region between the two dorsal stripes and remaining body dark in colour. The black intermittent spots clearly appeared along each lateral yellow stripes. Two parallel rows of black triangular spots run on the top of the larval body. The duration of fifth instar larva ranged from 2 to 4 days having an average of 3.30 ± 0.45 days.

3.3.6 Sixth instar

Larval colour gradually changed to earthy brown to black. Sides of the body were dark and ventral body light coloured. First and eighth abdominal segments possessed dark black spots that were clearly visible. Larva had a bright yellow stripe along the length of the dorsal surface. The full grown larva was smooth, stout and cylindrical with slightly tapered ends. The body was bulged and showed clear segmentation. The larva fed voraciously but later declined in feeding and transformed into an inactive pre-pupa. The duration of sixth instar larva ranged from 1 to 2 days having a mean duration of 1.93 ± 0.24 days.

3.3.7 Total larval period

The total larval period of *S. litura* ranged from 11 to 16 days with a mean period of 13.23 ± 1.68 days. Similarly, six larval instars on tobacco and larval development took to 13 days [7].

3.4 Pre-pupa

As soon as the larva became fully developed, it avoided feeding and became sluggish and gets curled into C-shape prior to pupation and called as pre-pupal stage. It moves inside the soil and construct a pupal cocoon inside soil. The pre-pupal duration ranged from 1 to 2 days having a mean period of 1.20 ± 0.40 days.

3.5 Pupa

Pupation takes place inside the soil into an earthen cocoon. Freshly formed pupa was light yellowish green and gradually turned into dark reddish brown later. The pupa was obtect with tapering ends and seven pairs of spiracles being clearly visible. A dark brown stripe developed on the mid dorsal line. Two pointed spine like structures were found on tip of the last abdominal segment. And when disturbed, it shows slight movements with its abdomen. Sexual dimorphism was clearly seen, male was slender with two conspicuous T-shaped slits with bulging on either side at 9th abdominal segment and the caudal tip was pointed. Female was relatively stout and genital aperture at 8th abdominal segment in the form of a slit with bulged sides. The pupal duration ranged from 6 to 8 days having a mean period of 7.03 ± 0.65 days.

Table 1: Biology of *Spodoptera litura* (Fab.) infesting soybean

Sr. no.	Stages of insect	No. observed	Minimum (Days)	Maximum (Days)	Mean (Days)	± SD
1.	Incubation period	30	2	3	2.63	0.48
2.	Larval period	30				
a.	I instar	30	2	3	2.43	0.49
b.	II instar	30	2	3	2.40	0.48
c.	III instar	30	3	4	3.23	0.61
d.	IV instar	30	2	4	2.80	0.58
e.	V instar	30	2	4	3.30	0.45
f.	VI instar	30	1	2	1.93	0.24
g.	Total larval period	30	11	16	13.23	1.68
3.	Pre pupal period	30	1	2	1.20	0.40
4.	Pupal period	30	6	8	7.03	0.65
5.	Adult longevity	10				
a.	Male	5	6	7	6.60	0.48
b.	Female	5	7	9	8.00	0.63
6.	Sex ratio	20	-	-	1:1.22	-
7.	Total life cycle	10				
a.	Male	5	28	34	31.40	2.03
b.	Female	5	30	36	33.4	2.15
8.	Pre oviposition period	5	2	3	2.8	0.74
9.	Oviposition period	5	3	4	3.4	0.48
10.	Post-oviposition	5	2	4	3.2	0.74
10.	Hatching percentage (%)	100	84	93.33	89.20	3.43
11.	Fecundity	5	188	252	216.8	23.81

SD standard deviation

3.6 Adult

S. litura adult was a medium sized moth, with dark coloured forewings and light coloured hind wings. The forewings are grey to brown with crisscross variegated pattern and pale white lines and the hind wings are creamy white with dark margin and brown venation. Adult female moths were having stout body than male moths. The female moth had brown tuft of hairs at the abdominal tip while it was absent in male. The male moth was having ashy grey patch on apical margin of forewings while it was absent in female. Longevity of females were more than that of males. The male moths were having a longevity of 6 to 7 days with an average of 6.60 ± 0.48 days while the female longevity varied from 7 to 9 days with a mean period of 8 ± 0.63 days. Similarly, the adult female period was 9 days and male period was 5 to 6 days, respectively with an average of 9.0 ± 0.0 and 5.5 ± 0.21 [8].

3.7 Pre-oviposition, oviposition period and post oviposition period

The pre-oviposition period ranged from 2 to 3 days with an average of 2.80 ± 0.74 days. Oviposition occurred during night hours. Three to four days after emergence, female moths lay eggs in masses. The oviposition period was 3 to 4 days with mean of 3.40 ± 0.48 days. Post oviposition period ranged from 2 to 4 days with an average of 3.2 ± 0.74 days.

3.8 Fecundity

Female moth started depositing the eggs at three to four days after emergence. Considerable variation existed in the egg laying by each female, which ranged from 188 to 252 eggs per female with an average of 216.80 ± 23.81 eggs per female. The fecundity of female of *S. litura* was 261 ± 1.56 eggs [4].

3.9 Total life span

The entire life cycle of *S. litura* was completed in 28 to 36 days with males having longevity of 28 to 34 days with an average of 31.40 ± 2.03 days and female longevity of 30 to 36 days with an average of 33.4 ± 2.15 days under laboratory conditions. Hence, female lived longer than male. Similar observations were recorded in castor with 28.25 to 36.00 days with an average of 32.13 ± 5.48 days [11].

3.10 Sex ratio

The sex ratio of male and female was depicted by counting the number of male and female adults emerged from 20 pupas. Out of 20 pupae 11 were female and 9 were male. The male-female ratio was 1:1.20. More female adults emerged than male from the pupa. Similarly, the male: female ratio was 1: 1.25 on cabbage [9].

4. CONCLUSIONS

The *S. litura* has a complete life cycle containing four stages viz., egg, larva, pupa and adult. It undergoes six larval instars, pre-pupa and pupal stages before attaining the adult stage. The larva passed through six instars with a period of 2.40 ± 0.48 , 2.40 ± 0.48 , 3.30 ± 0.64 , 2.80 ± 0.60 , 3.30 ± 0.45 and 1.80 ± 0.40 days, respectively with a total larval period of 13.50 ± 1.50 days. The key character to identify *S. litura* is adults were medium sized moth, with dark coloured forewings and light coloured hind wings. The forewings are grey to brown with crisscross variegated pattern and pale white lines and the hind wings are creamy white with dark margin and brown venation. The larva was black headed and colour varied from pale green to dark green to black in each instars with three yellow longitudinal lines on its body. The sex ratio was 1:1.22 and female lived longer than the male and the average fecundity of *S. litura* was found to be 216.8 ± 23.81 eggs. The total developmental period of *S. litura* was 31.40 ± 2.03 days (male) and 33.4 ± 2.15 days (female).

5. ACKNOWLEDMENT

The authors are highly grateful to the Director of Research, Junagadh Agricultural University, Junagadh, Gujarat (India) for providing the facilities required to conduct this experiment.

REFERENCES

- [1] Babu, S. R.; Kalyan, R. K.; Ameta, G. S. and Meghwal, M. L. (2015). Analysis of outbreak of tobacco caterpillar, *Spodoptera litura* (Fabricius) on soybean. *Journal of Agrometeorology*, **17**(1): 61.
- [2] Chauhan, G. S. and Joshi, O. P. (2005). Soybean (*Glycine max*) the 21st century crop. *Indian Journal of Agriculture Sciences*, **75**(8): 461-469.
- [3] Edrozo, L. B. (1918). A study of tobacco worms and methods of control. *Philippines Agriculturist and Forester*, **6**(7): 195-209.
- [4] Ghelani, A. B. (1989). Comparative bionomics of *Spodoptera litura* (Fabricius) on different host plants and its chemical control along with antifeedent activity of some plant derivatives. M. Sc. (Agri.) Thesis (Unpublished). Gujarat Agricultural University, Sardar Krushinagar.
- [5] Hill, D. S. (1993). Agricultural insect pests of the tropics and their control. Cambridge University Press. Cambridge, London. pp: 760.
- [6] Manja Naik, C.; Nataraj, K. and Santhoshakumara, G. T. (2017). Comparative biology of *Spodoptera litura* on vegetable and grain soybean [*Glycine max* (L.) Merrill]. *International Journal of Current Microbiology and Applied Sciences*, **6**(7): 366-371.
- [7] Patel, C. C. and Chari, M. S. (1987). Bio-ecological studies on tobacco leaf eating caterpillar, *Spodoptera*

- litura* (Fab.). *Tobacco Research*, **13**(1): 1-8.
- [8] Promod, K. S.; Masarrat, H. and Manzoor, U. (2015). Biology of tobacco cutworm, *Spodoptera litura*. *Biotic Environment*, **21**: 2-3.
- [9] Rabari, P. H.; Chauhan, N. J. and Dodia, D. A. (2018). Biology of *Spodoptera litura* (Fabricius) on cabbage. *International Journal of Chemical Sciences*, **6**(5): 1700-1705.
- [10] Rai, P. S.; Seshu reddy, K. V. and Govindan, R. (1973). A list of insect pests of soybean in Karnataka State. *Current Research*, **2**: 97-98.
- [11] Ramaiah, M. and Maheswari, T. U. (2018). Biology studies of tobacco caterpillar, *Spodoptera litura* Fabricius. *Journal of Entomology and Zoology Studies*, **6**(5): 2284-2289.
- [12] Simmond, H. W. (1925). A cutworm pest, *Prodenia litura* F. *Agricultural Circular of Department of Agriculture Fiji*, **5**: 86-87.