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**Gopika R**  
P.G. Scholar, Department of  
Agricultural Entomology,  
VNMKV, Parbhani,  
Maharashtra, India

**Dr. Sonkamble MM**  
Associate Professor (CAS),  
Department of Agricultural  
Entomology, College of  
Agriculture, Vasant Rao Naik  
Marathwada Krishi Vidyapeeth,  
Parbhani, Maharashtra, India

**Dr. Lad AG**  
Assistant Professor, Department  
of Agricultural Entomology,  
College of Agriculture, Vasant Rao  
Naik Marathwada Krishi  
Vidyapeeth, Parbhani,  
Maharashtra, India

**Corresponding Author:**  
**Dr. Sonkamble MM**  
Associate Professor (CAS),  
Department of Agricultural  
Entomology, College of  
Agriculture, Vasant Rao Naik  
Marathwada Krishi Vidyapeeth,  
Parbhani, Maharashtra, India

## Biology and morphometry of tobacco leaf eating caterpillar, *Spodoptera litura* on Cabbage (*Brassica oleracea* var. *capitata* L.)

**Gopika R, Dr. Sonkamble MM and Dr. Lad AG**

### Abstract

The experiments on biology were carried out in the laboratory of Department of Agricultural Entomology, VNMKV, Parbhani. According to studies on the biology of *Spodoptera litura*, the average incubation period was  $3.15 \pm 0.36$  days. The larvae go through six instars and five moults. The duration for completing six larval instars were  $14.2 \pm 1.12$  days. Pupal period lasted for  $7.45 \pm 1.14$  days. The pre-oviposition, oviposition and post-oviposition period lasted for  $2.8 \pm 0.91$ ,  $7.5 \pm 0.62$  and  $2.00 \pm 0.66$  days respectively. The average fecundity was  $887 \pm 30.25$  eggs per female. The total developmental period ranging between 31 to 36 days with mean of  $33.6 \pm 1.60$  days.

**Keywords:** Biology, *Spodoptera*, head borer, larva, duration

### Introduction

Vegetables are grown throughout our country under a variety of agro-climatic conditions. It contributes to a healthy diet by providing not only energy but also essential protective nutrients such as minerals and vitamins. Because of their nutritional richness, short duration, high yield, and economic value, they are increasingly recognised as essential for food and nutrition security. Cole crops have an advantage over other winter vegetables and are grown throughout the country.

The cabbage crop is infested with multiple insect pest complexes, which are one of the major limiting factors in crop production by causing significant damage. Among these, *Spodoptera litura* has wider range of host plants nearly 120 including weeds, ornamentals, crops and vegetables (Ramana *et al.* 1988) [11]. It has a global distribution and a cosmopolitan food habit, feeding on economically important plants. The leaf worm, *Spodoptera litura* causes economic losses of crops ranging from 25.8-100 per cent based on crop stage and its infestation level in the field (Dhir *et al.* 1992) [4]. It feeds gregariously on leaves leaving midrib veins only. The larval stage causes the most damage, which is often severe. Considering the above mentioned issues, it was necessary to investigate the biology of *S. litura* on cabbage crop under laboratory conditions.

### Materials and Methods

The larvae collected in the field were reared in the laboratory in round clean plastic boxes on cabbage. The open ends of plastic boxes were covered with perforated lids to allow for aeration. After removing excreta and partially eaten leaves from plastic boxes, the diamond back moth larvae were fed a sufficient amount of fresh cabbage leaves every day until the larvae matured to pupa.

All pupae were placed in separate boxes for adult emergence. Regular collections began as soon as adult moths emerged from pupae and lasted until the last adult moth emerged. A newly emerged male and female moth was carefully placed in an oviposition plastic jar for egg laying. To keep the leaves turgid, the cut ends of fresh cabbage leaves were dipped in a conical flask filled with water.

The conical flask with leaves was placed inside the plastic jar, which was wrapped in muslin cloth and tightened with a rubber band. Adults were given a 5 percent honey solution as a comfort food. On a daily basis, female egg laying was observed on cabbage leaves. The eggs were removed from the leaves, and fresh leaves were provided on a regular basis. Freshly laid eggs were used in further research. The number of instars, duration of instars, and total larval period on cabbage were manually counted.

## Results and Discussion

Observations on biological parameters are presented in Table 1 and morphometrical parameters are presented in Table 2.

### Egg

Female moths laid their eggs in clusters or masses on the leaf as well as in the side walls of plastic jar. The eggs were nearly round in shape and pale green in colour when they were freshly laid, but after a few hours, they turned whitish green in colour. The average length and breadth of egg varied from 0.55 to 0.59mm and 0.48 to 0.50mm respectively with mean of  $0.57 \pm 0.01$  and  $0.48 \pm 0.06$ mm respectively. The present results were close conformity with Rabari *et al.* (2018)<sup>[9]</sup> who reported the average length and breadth of egg was  $0.58 \pm 0.02$  and  $0.49 \pm 0.02$ mm respectively.

The incubation period of eggs ranging from 3 to 4 days with an average of  $3.15 \pm 0.36$  days. The present results were close confirmation with earlier workers such as Ramaiah and Maheshwari (2018)<sup>[10]</sup> who reported to be 3 days.

### Larva

From the present study, it was found that the caterpillars had six larval instars and moulted five times during their larval period

#### 1<sup>st</sup> instar

The neonate larvae were pale green in colour with a dark black head, distinctly visible black hairs on the body. The duration of first instar larvae was ranged between 2 to 3 days with an average of  $2.68 \pm 0.47$  days. The results of the present findings with regard to duration of first instar were comparable with the reports of Ramaiah and Maheshwari (2018)<sup>[10]</sup> who recorded as 2 to 3 days with an average of  $2.5 \pm 0.71$  days.

The average length and breadth of first instar average ranging between 1.28 to 1.65mm and 0.23 to 0.32mm respectively with mean value of  $1.50 \pm 0.16$  and  $0.27 \pm 0.02$ mm respectively. Similar findings were made by Rabari *et al.* (2018)<sup>[9]</sup> who recorded the average length and breadth to be  $1.48 \pm 0.11$  and  $0.32 \pm 0.04$ mm respectively.

#### 2<sup>nd</sup> instar

The larva's size increased slightly during the second instar, and its colour changed from light green to dark green. The duration of second instar larvae ranging between 2 to 4 days with an average of  $2.72 \pm 0.76$  days. Thus the present results were more or less in confirmation with of Rabari *et al.* (2018)<sup>[9]</sup> who recorded it as 2 to 4 days with an average of  $2.96 + 0.73$  days.

The average length and breadth of second instar ranging between 3.55 to 4.00mm and 0.44 to 0.71mm respectively with mean value of  $3.83 \pm 0.21$  and  $0.50 \pm 0.08$ mm respectively. The present finding has close conformity with Rabari *et al.* (2018)<sup>[9]</sup> who reported the average length and breadth of second instar as  $3.78 \pm 0.10$  and  $0.72 \pm 0.06$ mm respectively.

#### 3<sup>rd</sup> instar

The third instar larvae developed a dark green body colour with two dorsal black spots on the first abdominal segment and dark crescent shaped spots on the sides of the following abdominal segment. The duration of third instar ranging between 3 to 4 days with an average of  $3.18 \pm 0.50$  days. The present results were more or less indirection with Rabari *et al.*

(2018)<sup>[9]</sup> who recorded it as 3 to 5 days with an average of  $3.36 \pm 0.64$  days and Ramaiah and Maheshwari (2018)<sup>[10]</sup> who reported it as 3 to 4 days with an average of  $3.50 \pm 0.71$  days.

The average length and breadth of third instar varied from 9.7 to 11.97mm and 1.34 to 1.55mm respectively with mean of  $10.97 \pm 0.83$  and  $1.46 \pm 0.06$ mm respectively. The present results were more or less in direction with previous workers like Rabari *et al.* (2018)<sup>[9]</sup> who reported the length and breadth of third instar as  $10.52 \pm 0.33$  and  $1.38 \pm 0.10$ mm respectively. Ramaiah and Maheshwari (2018)<sup>[10]</sup> recorded the length and breadth of third instar as  $11.92 \pm 1.48$  and  $1.49 \pm 0.06$  respectively which is also supporting this research.

#### 4<sup>th</sup> instar

The fourth instar larva ranged in colour from dark grey to olive green. The duration of fourth larval instar ranging from 3 to 4 days with an average of  $3 \pm 0.53$  days. Similar findings were made by Rabari *et al.* (2018)<sup>[9]</sup> who reported it as 2 to 4 days with an average of  $3.06 \pm 0.68$  days and more or less indirection with Ashwini (2014)<sup>[2]</sup> who reported it an average of  $3.52 \pm 0.42$  days.

The length and breadth of fourth instar varied from 16.55 to 19.20mm and 1.42 to 1.54mm respectively with mean value of  $17.33 \pm 0.86$ mm and  $1.46 \pm 0.04$ mm respectively. Similar comparable results were obtained by Ashwini (2014)<sup>[2]</sup> who reported the length and breadth of fourth instar to be  $17.48 \pm 0.71$  and  $1.42 \pm 0.08$ mm respectively.

#### 5<sup>th</sup> instar

The colour of the fifth instar larvae ranged from light green to dark brown, with a dark brown head. The duration of fifth instar larvae was ranging between 3 to 4 days with an average of  $3.22 \pm 0.42$  days. Similar findings were made by few previous workers such as Rabari *et al.* (2018)<sup>[9]</sup> who reported it to be 3 to 4 days with an average of  $3.28 + 0.46$  days whereas Kumar and Bhattacharya (2019) recorded it as 3 days.

The average length and breadth of fifth instar ranging between 24.25 to 27.45mm and 2.71 to 3.20mm respectively with mean of  $25.23 \pm 1.07$ mm and  $2.94 \pm 0.19$ mm respectively. Similar comparable results were recorded by Ashwini (2014)<sup>[2]</sup> who reported the average length and breadth to be  $24.29 \pm 1.72$  and  $2.02 \pm 0.10$ mm respectively. Rabari *et al.* (2018)<sup>[9]</sup> recorded the length and breadth of fifth instar as  $26.30 \pm 0.81$  and  $2.96 \pm 0.15$  respectively.

#### 6<sup>th</sup> instar

During the sixth instar, fully grown larvae became stout, smooth, and cylindrical, and they also stopped feeding. The larva was velvety black or blackish green in colour. The duration of sixth instar larvae ranging between 2 to 3 days with an average of  $2.70 \pm 0.50$  days respectively. The present findings were close similarity with Rabari *et al.* (2018)<sup>[9]</sup> who reported it as 2 to 3 days with an average of  $2.76 \pm 0.50$  days where as Kumar and Bhattacharya (2019) observed it as 2.8 days, which is also supported to this study.

The average length and breadth of sixth instar ranging between 32.20 to 37.65mm and 3.89 to 4.50mm respectively with mean value of  $35.40 \pm 1.59$  and  $4.22 \pm 0.26$ mm respectively. Similar comparable results were obtained by Rabari *et al.* (2018)<sup>[9]</sup> who reported the length and breadth of sixth instar to be  $35.32 \pm 0.87$  and  $4.24 \pm 0.17$ mm respectively.

### Total larval period

The duration of six larval instars were ranging from 13 to 16 days with an average of  $14.2 \pm 1.12$  days. The present findings were more or less similar to Tuan *et al.* (2015) [15] recorded the total larval period of  $14.3 \pm 0.2$  days whereas, Yadav (2020) [17] reported as 14.54 days. Shahout *et al.* (2011) [13] recorded the total larval period average of 15.55 days.

### Pre pupa

The mature larvae curled into a C-shape before pupation. The pre-pupa was dark brown or lighter reddish in colour and developed a slightly greenish colour at the sternum. Similar characters were observed by Ramaiah and Maheshwari (2018) [10].

The pre pupal period ranging from 2 to 3 days with an average of  $2.02 \pm 0.10$  days. Similar findings were made by Narevkar *et al.* (2018) who reported the pre pupal period of 2 days, Tuan *et al.* (2015) [15] also recorded the same mean value of  $2.0 \pm 0.0$  days.

### Pupa

Pupae were initially pale yellowish in colour later it became dark reddish brown in colour. The duration of pupal period varied from 6 to 10 days with an average of  $7.45 \pm 1.14$  days. The present findings were close conformity with Ramaiah and Maheshwari (2018) [10] who reported the pupal period of 7 to 8 days with an average of  $7.50 \pm 0.71$  days whereas, Yadav (2020) [17] recorded it as 7.96 days.

The average length and breadth of pupa varied from 12.22 to 14.95mm and 4.2 to 5.45mm respectively with mean of  $14.00 \pm 0.97$ mm and  $4.62 \pm 0.37$ mm respectively. The present results were close conformity with Ramaiah and Maheshwari (2018) [10] who reported the average length and breadth of pupa were  $14.05 \pm 2.26$  and  $4.87 \pm 0.89$ mm respectively.

### Pre-oviposition, oviposition and post-oviposition period

According to the results obtained from this study, the duration of pre-oviposition period varies between 2 to 4 days with an average of  $2.8 \pm 0.91$  days. The present results are in close conformity with Ashwini (2014) [2] who reported the pre-oviposition period as  $2.94 \pm 0.33$  days. Rabari *et al.* (2018) [9] reported it as 1 to 2 days with an average of  $1.52 \pm 0.51$  days which is also more or less conformity with present investigations. Ramaiah and Maheshwari (2018) [10] recorded it as 2.5 to 3.75 days with an average of  $3.13 \pm 0.88$  days which is also supporting to this results.

The duration of oviposition period varied from 6 to 8 days with an average of  $7.5 \pm 0.87$  days respectively. Similar findings were made by Rabari *et al.* (2018) [9] who reported the average oviposition period of 6 to 10 days with an average of  $7.72 \pm 1.37$  days whereas, Tuan *et al.* (2015) [15] recorded as  $7.8 \pm 0.5$  days.

The duration of post-oviposition period was ranging between 1 to 3 days with an average of  $2 \pm 0.66$  days. This results were more or less indirection with Rabari *et al.* (2018) [9] who reported the duration of 1 to 3 days with an average of  $1.48 \pm 0.1$  days.

### Adults

Adult moths were yellowish brown in colour, with a prominent head and black compound eyes. The forewings of the adult moth were brown with a complex pattern of creamy coloured criss-crossing markings. The hind wings were a silvery white colour. The females were bigger than the male.

Females were identified by a tuft of hairs at the end of abdomen. The wing expanse of female and male ranging between 12.50 to 18.22 and 11.35 to 16.00mm respectively with mean value of  $16.15 \pm 1.75$  and  $15.13 \pm 1.67$ mm respectively. Similar findings were obtained by Ramaiah and Maheshwari (2018) [10] who reported the wing expanse of female and male as  $17.25 \pm 2.00$  and  $16.25 \pm 2.81$ mm respectively.

### Adult longevity

The longevity of male moth varied from 6 to 8 days with an average of  $7.2 \pm 0.78$  days. The present investigations were close conformity with Xue *et al.* (2010) [16] who reported the average longevity of male as  $7.4 \pm 0.2$  days whereas, Ashwini (2014) [2] recorded an average of  $7.99 \pm 0.45$  days which is also supporting to this results. The longevity of female varied from 7 to 9 days with an average of  $8.6 \pm 0.69$  days. The present findings were close conformity with Ramaiah and Maheshwari (2018) [10] who reported it has ranging from 7 to 9 days with an average of  $8.00 \pm 1.41$  days Whereas, Jadhav *et al.* (2015) [5] reported that the adults survived for 9 to 12 days which is also supporting to this study.

### Fecundity

The egg laying capacity of female ranging between 832 to 923 eggs with an average of  $887 \pm 30.25$  eggs. Females have a longer life expectancy than males. Similar findings were made by Ramaiah and Maheshwari (2018) [10] who reported it has ranging from 879 to 902 eggs with an average of  $890.50 \pm 16.26$  eggs.

### Total lifecycle

The total life cycle from egg to adult ranged between 31 to 36 days with an average of  $33.6 \pm 1.60$  days. The results of the present findings were more or less in confirmation with Yadav (2020) [17] who reported the total life span of *Spodoptera litura* was 32.94 days. Ramaiah and Maheshwari (2018) [10] reported that *Spodoptera litura* takes 28.25 to 36.00 days with a mean of  $32.13 \pm 5.48$  days to complete its life cycle. These previous works are also supporting the results of present study.

**Table 1:** Biological parameters of tobacco leaf eating caterpillar *Spodoptera litura* reared on cabbage leaves (N=20)

Sr. no.	Particular	Range	Mean± SD
1	Incubation period (days)	3-4	$3.15 \pm 0.36$
2	<b>Larval period(days)</b>		
	1 <sup>st</sup> instar	2-3	$2.68 \pm 0.47$
	2 <sup>nd</sup> instar	2-4	$2.72 \pm 0.76$
	3 <sup>rd</sup> instar	3-4	$3.18 \pm 0.50$
	4 <sup>th</sup> instar	3-4	$3.00 \pm 0.53$
	5 <sup>th</sup> instar	3-4	$3.22 \pm 0.42$
	6 <sup>th</sup> instar	2-3	$2.70 \pm 0.50$
3	Total larval period	13-16	$14.2 \pm 1.12$
4	Pre pupal period(days)	2-3	$2.02 \pm 0.10$
5	Pupal period(days)	6-10	$7.45 \pm 1.14$
6	<b>Adult longevity (days)*</b>		
	Male	6-8	$7.2 \pm 0.78$
	Female	7-9	$8.6 \pm 0.69$
7	Pre-oviposition period(days)*	2-4	$2.8 \pm 0.91$
8	Oviposition period(days)*	6-8	$7.5 \pm 0.87$
9	Post-oviposition period(days)*	1-3	$2.00 \pm 0.66$
10	Fecundity (No. of eggs/female)*	832-923	$887 \pm 30.25$
11	Total developmental period(days)*	31-36	$33.6 \pm 1.60$

\*Mean of ten observations

**Table 2:** Morphometry of Various stages of tobacco leaf eating caterpillar *Spodoptera litura* reared on cabbage leaves (N=10)

Life stages	Length (mm)		Breadth (mm)	
	Range	Mean± SD	Range	Mean ± SD
Egg	0.55-0.59	0.57±0.01	0.48-0.50	0.48±0.06
<b>Larval instars</b>				
1 <sup>st</sup> instar	1.28-1.65	1.50±0.16	0.23-0.32	0.27±0.02
2 <sup>nd</sup> instar	3.55-4.00	3.83±0.21	0.44-0.71	0.50±0.08
3 <sup>rd</sup> instar	9.70-11.97	10.97±0.83	1.34-1.55	1.46±0.06
4 <sup>th</sup> instar	16.55-19.20	17.33±0.86	1.42-1.54	1.46±0.04
5 <sup>th</sup> instar	24.15-27.45	25.23±1.07	2.71-3.20	2.94±0.19
6 <sup>th</sup> instar	32.20-37.65	35.40±1.59	3.89-4.50	4.22±0.26
Pupa	12.22-14.95	14.00±0.97	4.20-5.45	4.62±0.37
<b>Adult (Breadth at wing expanse)</b>				
Female	12.50-18.22	16.15±1.75	-	-
Male	11.35-16.00	15.13±1.67	-	-

### Conclusions

For effective control of insect pests the knowledge about the number of larval instars and other information concerning with insect biology is also needed for developing pest forecasting models based crop phenology or in the refinement of existing models.

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