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LIFE CYCLE AND BIOLOGY OF *SPODOPTERA LITURA* (NOCTUIDAE: LEPIDOPTERA) INFESTING COTTON

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ABSTRACT

The present study investigated the biology of *Spodoptera litura* (Fabricius), a major lepidopteran pest of cotton, under laboratory conditions using populations collected from infested fields at the Main Cotton Research Station (MCRS), Navsari Agricultural University, Surat, Gujarat. Egg masses were collected from the field and reared on cotton to document key developmental parameters. The incubation period averaged 3.00 ± 0.00 days, followed by a larval duration of 15.00 ± 5.66 days. The prepupal and pupal stages lasted 0.90 ± 0.14 and 8.00 ± 1.41 days, respectively, with the total life cycle completed in 35.4 ± 7.92 days. Fecundity was high, with females laying an average of 897.5 ± 10.61 eggs and achieving a hatching rate of 88.5 ± 4.95%. Sexual dimorphism was evident, with females exhibiting greater longevity and larger body size compared to males. These findings provide baseline biological information on *S. litura* populations from Gujarat, which can aid in developing region-specific pest management strategies.

***Key words*: *Spodoptera litura*, cotton, larvae, IPM, & Morphometric**

Introduction

Cotton (*Gossypium hirsutum* L.) is one of the world's most important fiber crops, cultivated in more than 80 countries across tropical and subtropical regions (Delhom *et al.*, 2024). In India, cotton has historically held cultural and economic significance, forming the backbone of the textile industry and rural livelihoods. With over 9.6 million hectares under cultivation, India accounts for nearly 25% of global cotton acreage and 16% of world production (Khadi *et al.*, 2010). The central cotton zone, encompassing Gujarat, Maharashtra, and Madhya Pradesh, contributes approximately 95% of the national output (Singh and Kairon, 2001). Despite its economic importance, cotton productivity is adversely affected by various biotic and abiotic constraints.

Among insect pests, *Spodoptera litura* (Fabricius), commonly known as the tobacco cutworm or cotton leafworm, is considered one of the most destructive species due to its polyphagy, rapid reproductive rate, and capacity to cause significant yield losses. In India, *S. litura* infestation results in 10–30% yield reduction depending on agro-climatic conditions and pest management practices (Rajendran *et al.*, 2018; Abhishek and Patel, 2011). Native to South and Southeast Asia, this pest is a serious constraint in the Asia-Pacific region. Its larvae feed indiscriminately on foliage and other plant parts of more than 120 host species, including cotton, soybean, groundnut, and vegetables (Selvaraj *et al.*, 2010). Newly hatched larvae feed gregariously, but from the third instar onward, they disperse individually using silken threads

and cause extensive defoliation. A single female moth can lay more than 2,000 eggs during her short 6–8 days lifespan, usually in overlapping layers that hatch within 2–3 days (Ahmad *et al.*, 2013).

Under favourable conditions, the pest completes its life cycle in about 25 days, enabling rapid population build-up and frequent outbreaks (Kumar and Bhattacharya, 2019; Kumar and Prasad, 2020). Given its high reproductive potential, adaptability, and destructive feeding behavior, understanding the biology of *S. litura* on cotton under local conditions is critical for developing sustainable and region-specific pest management strategies (Sharma *et al.*, 2022; Ramzan *et al.*, 2020).

Materials and Method

Biological Studies of *S. litura*

The biology of *Spodoptera litura* was investigated under controlled laboratory conditions (26 ± 2°C temperature, 70 ± 5 per cent relative humidity, and a 12:12 hr light:dark photoperiod) at the Department of Entomology, N. M. College of Agriculture, NAU, Navsari, during 2024 (Satiman *et al.*, 2022; Kumar *et al.*, 2024).

Mass Rearing

Egg masses of *Spodoptera litura* were collected from cotton fields at MCRS, NAU, Surat, and transferred to sterilized containers lined with blotting paper (Fig. 1). Fresh cotton leaves on moist filter paper were provided daily, and containers were disinfected with 70% ethanol. From the third instar onward, larvae were reared individually to prevent cannibalism (Sandhyarani and Rani, 2013). Fully developed larvae were transferred to soil-filled containers for pupation, and pupae were sexed based on external morphology before being maintained separately until adult emergence (Ramaiah, 2018). Morphometric traits of larvae, pupae, and adults were recorded following the method of Natikar and Balikai (2017).

Mating and Fecundity

Immediately after adult emergence, moths were paired (1B&:1@&) in transparent jars containing a cotton swab soaked in 10% honey solution and lined with white paper as an oviposition substrate. Five pairs were maintained to record the pre-oviposition and oviposition periods, fecundity, egg hatchability, and the longevity of both sexes (Ramaiah, 2018).

Developmental Stages

Egg Stage

The incubation period was recorded from the day of oviposition until hatching of the first instar larvae. Eggs were examined daily under a stereomicroscope to observe changes in color and embryonic development. The proportion of hatched eggs was used to calculate egg viability Gupta *et al.*, 2015; Ashwini *et al.*, 2016).

Larval Stage

Newly hatched larvae were reared in groups during the first and second instars to account for their gregarious feeding behavior. From the third instar, larval density was reduced to 5–10 per container, and from the fourth instar onward, individuals were reared separately to prevent cannibalism. Fresh cotton leaves were provided daily, and containers were replaced with sterilized ones on alternate days. The number and duration of instars, along with morphometric traits such as body length and head capsule width, were recorded, along with observations on feeding intensity and dispersal behavior (Gopika *et al.*, 2021; Ashok and Pavithran, 2021).

Pupal Stage

Fully grown larvae were transferred to soil-filled containers for pupation. The duration of the pupal stage

Fig. 1: Mass rearing of *S. litura* in the laboratory. **A)** Emergence of early first instar larvae from the egg mass, **B)** First and second instar larvae feeding on leaf, **C)** Larvae feeding on fresh leaf provided as diet, **D)** Pupation, **E)** Emergence of Adult moth from the pupae.

Table 1: Biology of *S. litura* (Fab.) in cotton.

Sr. No.	Stage of the insect	Min. (Days)	Max. (Days)	Mean (days)	± SD
1	Incubation period	3.00	3.00	3.00	0.00
2	Larval period				
	I instar	2.00	3.00	2.50	0.71
	II instar	2.00	4.00	3.00	1.41
	III instar	3.00	4.50	3.75	1.06
	IV instar	2.00	3.50	2.75	1.06
	V instar	2.00	4.00	3.00	1.41
	Total larval period	11.00	19.00	15.00	5.66
3	Pre pupal period	0.80	1.00	0.90	0.14
4	Pupal period	7.00	9.00	8.00	1.41
5	Adult longevity				
	Male	6.00	8.00	7.00	1.41
	Female	8.00	9.00	8.50	0.71
	Average	7.00	8.50	7.75	1.06
6	Total life cycle	29.8	41.00	35.40	7.92
7	Pre oviposition period	2.50	3.50	3.00	0.71
8	Oviposition period	3.50	4.50	4.00	0.71
9	Fecundity (no.)	890.00	905.00	897.50	10.61
10	Percent of hatching	85.00	92.00	88.50	4.95

was recorded from pupation to adult emergence (Aravinthraju *et al.*, 2022; Ojumoola and Omoloye, 2022). A representative sample of five pupae was observed daily to monitor morphological changes such as cuticle hardening and color transition. Pupae were sexed based on external genital characteristics to assess sex ratio.

Adult Stage

Newly emerged moths were separated by sex and maintained individually in plastic jars. Each jar contained a cotton swab soaked in 10% honey solution as an adult food source. Longevity of males and females was recorded separately. Mating behavior, pre-oviposition and oviposition periods, and total fecundity were monitored by providing white paper sheets as oviposition substrates (Ahmad *et al.*, 2007).

Oviposition and Larval Behavior

Oviposition behavior was compared under field and laboratory conditions. In the field, females generally deposited egg masses on the underside of cotton leaves, often covered with yellowish-brown hairs, whereas in laboratory conditions eggs were mostly laid on cloth or paper substrates with little or no hairy covering. Larval behavior was studied from hatching to pupation (Shalaby *et al.*, 2025; Afroz, 2025). Changes in egg color prior to hatching, gregarious feeding by early instars, and solitary voracious feeding in later instars were carefully recorded. First and second instars skeletonized the leaf surface, giving it a papery appearance, while third to fifth instars

Table 2: Morphometrics of the life stages of cotton *S. litura* (Fab.).

Sr. No.	Stage of the insect	Min. (mm)	Max. (mm)	Mean	SD
1	**Egg**				
	Diameter	0.42	0.45	0.43	0.02
2	**First instar larva**				
	Length	1.20	5.50	3.35	3.04
	Breadth	0.30	0.40	0.35	0.07
3	**Second instar larva**				
	Length	6.50	8.50	7.50	1.41
	Breadth	1.20	1.50	1.35	0.21
4	**Third instar larva**				
	Length	15.70	16.80	16.25	0.78
	Breadth	3.20	3.50	3.35	0.21
5	**Fourth instar larva**				
	Length	19.70	22.90	21.30	2.26
	Breadth	4.50	4.60	4.55	0.07
6	**Fifth instar larva**				
	Length	33.70	38.90	36.30	3.68
	Breadth	4.60	4.80	4.70	0.14
7	**Pupa**				
	Length	14.50	16.80	15.65	1.63
	Breadth	3.70	4.5.00	4.10	0.57
8	**Adult**				
	Body length				
	Male	15.00	17.00	16.00	1.41
	Female	16.00	19.00	17.50	2.12

consumed entire leaf laminae, causing severe defoliation (Ramaiah, 2018).

Result And Discussion

Biological and Morphometric Characterization of *S. litura* under Laboratory Conditions

The biology of *S. litura* was studied under controlled laboratory conditions on cotton, using egg masses collected from infested fields at MCRS, NAU, Surat. Key developmental and reproductive traits were recorded, including incubation, duration of each larval instar, total larval period, prepupal and pupal stages, pre-oviposition and oviposition periods, fecundity, hatching percentage, adult longevity, and overall life cycle duration (Table 1). For morphometric analysis, individuals from each stage were measured on millimeter-marked graph paper to obtain standardized estimates of body length and width for eggs, larvae, pupae, and adults.

Egg Stage

Females laid an average of 897.5 ± 10.61 eggs, mostly at night, in compact clusters covered with yellowish-brown abdominal hairs (Table 2). These protective hairs

provide camouflage against natural enemies, as also noted by Ahmad *et al.*, (2013). Eggs were spherical, smooth, and creamy yellow, measuring 0.43 ± 0.02 mm in diameter. The incubation period averaged 3.00 ± 0.00 days, with a hatchability of 88.5 ± 4.95%, which closely matches reports by Mogili Ramaiah and Uma Maheswari (2018) who documented 85–90% hatchability. Darkening of eggs before hatching was a consistent indicator of embryo development.

Larval Development

First Instar:

Newly hatched larvae were pale green with shiny black head capsules and scattered setae. A black spot was observed on the first abdominal segment. Feeding was restricted to the epidermis, leaving papery patches. This stage lasted 2.50 ± 0.71 days, with larvae measuring 3.35 ± 3.04 mm in length. Early gregarious feeding and restricted tissue damage at this stage corroborate the findings of Selvaraj *et al.*, (2010).

Second Instar:

Larvae turned opaquer pale green, with smoother integument and reduced setae. Feeding intensity increased, with characteristic skeletonization of leaves. The instar lasted 3.00 ± 1.41 days, with larvae reaching 7.5 ± 1.41 mm in length. This shift to active defoliation corresponds with observations by Abhishek and Patel (2011), who emphasized the second instar as the stage of visible crop damage onset.

Third Instar:

Larvae became dark green with two black dorsal spots on the first abdominal segment and crescent-shaped lateral markings. Three faint yellow dorsal bands developed along the body. The instar lasted 3.75 ± 1.06 days, with body length reaching 16.25 ± 0.78 mm. The appearance of distinctive markings and greater mobility supports the adaptive camouflage function highlighted by Kumar and Prasad (2020).

Fourth Instar:

Body coloration shifted to bluish-green dorsally, with a prominent orange central dorsal band and yellow lateral bands accompanied by black dots. The ventral side was pale greenish-yellow, with a tougher integument. This instar lasted 2.75 ± 1.06 days, with larvae reaching 21.3 ± 2.26 mm. The development of stronger mandibles and a thicker cuticle, as also described by Aravinthraju *et al.* (2022), facilitated heavier feeding.

Fifth Instar:

Final instar larvae were dark blackish-brown with prominent longitudinal stripes (one orange and two yellow) and dense black dots (Fig. 2). Feeding was voracious, often reducing leaves to midribs. This stage lasted 3.00 ± 1.41 days, with larvae growing to 36.3 ± 3.68 mm in length and 4.7 ± 0.14 mm in breadth. The total larval duration was 13.50 ± 3.54 days. The extreme defoliation capacity of this stage aligns with reports by Rajendran *et al.*, (2018), who identified the fifth instar as the most damaging phase in cotton fields.

Prepupal and Pupal Stages

The prepupal stage lasted 0.90 ± 0.14 days, characterized by cessation of feeding and typical C-shaped curling. Pupae were initially soft and pale, later turning reddish-brown and shiny upon sclerotization. Distinct sexual dimorphism was evident: males had an X-shaped genital aperture, while females exhibited a V-shaped aperture. The pupal period averaged 8.00 ± 1.41 days, with pupal size 15.65 ± 1.63 mm × 4.1 ± 0.57 mm. Similar developmental durations and morphological features were reported by Ahmad *et al.*, (2013) and Mogili Ramaiah & Uma Maheswari (2018).

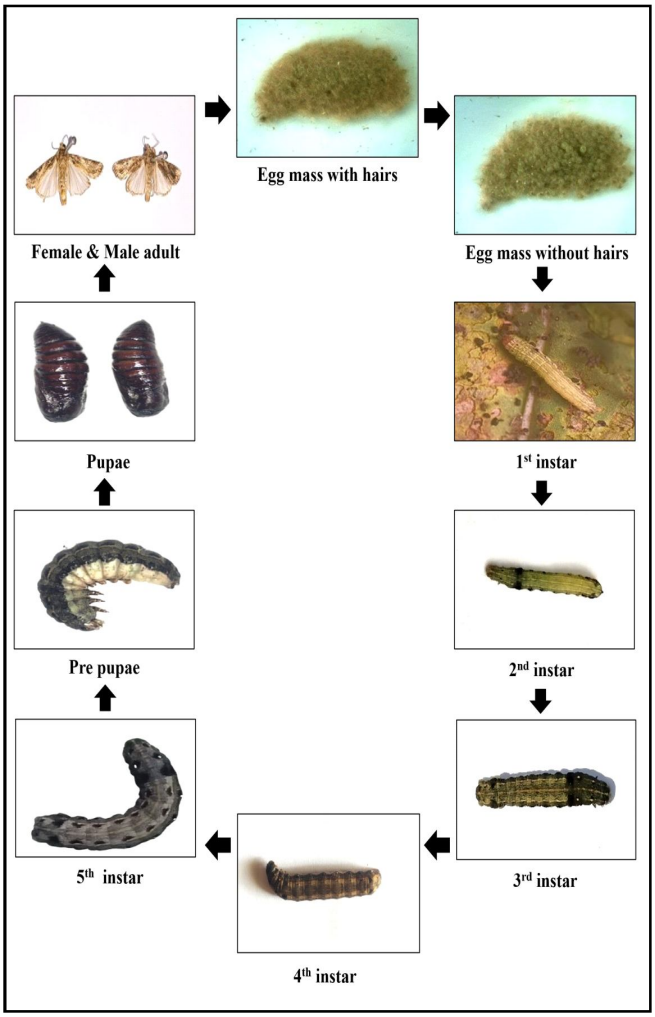

Fig. 2: Life cycle of *Spodoptera litura.*

Adult Stage

Adults were medium-sized moths with brown forewings marked with creamy-white crisscross patterns and silvery-white hindwings bordered with darker margins. Males were comparatively brighter and displayed a distinct white band on the forewings, while females were larger (17.5 ± 2.12 mm) than males (16 ± 1.41 mm). These traits are in agreement with descriptions by Selvaraj *et al.*, (2010).

Life Cycle Duration

The complete life cycle from egg to adult ranged 29.8–41.0 days, with an average of 35.4 ± 7.92 days on cotton. This closely agrees with the 25–40 days cycle reported on other host plants by Ahmad *et al.*, (2013) and Aravinthraju *et al.*, (2022). The observed differences likely reflect host plant quality and environmental conditions.

Conclusion

The biological characterization of *Spodoptera litura* on cotton under controlled laboratory conditions revealed a relatively short developmental cycle, high egg hatchability, and substantial fecundity, highlighting its capacity to establish and proliferate rapidly in cotton-growing ecosystems. Distinct morphometric traits at successive larval instars, along with clear sexual dimorphism in pupal and adult stages, provide reliable markers for stage-wise identification and monitoring. The comprehensive data generated on developmental duration, reproductive potential, and morphometric variation establish a baseline framework essential for understanding the pest's biology on cotton. Such information is valuable for predicting population dynamics, refining laboratory rearing protocols, and supporting the design of sustainable integrated pest management (IPM) strategies for effective control of *S. litura* in cotton production systems.

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References

Abhishek, S. and Patel B.V. (2011). Biology of *S. litura* (Fabricius) on banana. *International Journal of Plant Protection*, **4(1)**, 143-145.

Afroz, A. (2025). Biology and Management of *Spodoptera litura* on Cabbage in Laboratory Conditions. *Journal of Experimental Agriculture International*, **47(1)**, 300-307.

Ahmad, M., Arif M.I. and Ahmad M. (2007). Occurrence of insecticide resistance in field populations of *Spodoptera litura* (Lepidoptera, Noctuidae) in Pakistan. *Crop Protection*, **26(6)**, 809-817.

Ahmad, M., Ghaffar A. and Rafiq M. (2013). Host plants of leaf worm, *Spodoptera litura* (Fabricius) (Lepidoptera, Noctuidae) in Pakistan. *Asian Journal of Agriculture and Biology*, **1(1)**, 23-28.

Aravinthraju, K., Moorthy A.V. and Roopika M. (2022). Biology of *Spodoptera litura* (Fab.) in cassava, *Manihot esculenta* (L.). *The Pharma Innovation Journal*, **11(7)**, 813-814.

Ashok, K. and Pavithran S. (2021). Biology and morphometrics of *Spodoptera litura* (F.) on castor. *Indian Journal of Entomology*, **83**, e20289.

Ashwini, S.B., Ashoka J., Bheemanna M., Hanchinal S.G. and Diwan J.R. (2016). Biology and morphometry of *Spodoptera litura* (Fab.) on cabbage. *Environment and Ecology*, **34(4)**, 1764-1767.

Delhom, C.D., Wanjura J.D. and Hequet E.F. (2024). Cotton fibre elongation, a review. *The Journal of The Textile Institute*, **115(1)**, 159-170.

Gopika, R., Sonkamble M. and Lad A. (2021). Biology and morphometry of tobacco leaf eating caterpillar, *Spodoptera litura* on cabbage (*Brassica olearacea* var. *capitata* L.). *The Pharma Innovation Journal*, **10**, 1568-1571.

Gupta, M., Tara J.S., Sharma S. and Bala A. (2015). Biology and morphometry of *Spodoptera litura* Fabricus, a serious defoliator of Mango (*Mangifera indica*) in Jammu Region (J&K). *Munis Entomology and Zoology*, **10**, 215-221.

Khadi, B.M., Santhy V. and Yadav M.S. (2010). Cotton, an introduction. *Cotton, Biotechnological Advances*, **65**, 1-14.

Kumar, H.D. and Bhattacharya S. (2019). Biology of *Spodoptera litura* (Fabricius) on different crop plants. *Journal of Entomological Research*, **43(2)**, 165-168.

Kumar, N. and Prasad S.K. (2020). Influence of biotic factors on the life cycle of *Spodoptera litura* (Fabricius) on different host plants. *Journal of Entomology and Zoology Studies*, **8(1)**, 186-190.

Kumar, R., Sharma S.K., Goswami T.N. and Ahmed, N. (2024). Morphometric Studies of Tobacco Caterpillar, [*Spodoptera litura* (Fabricius)] on Different Host Plants. *International Journal of Plant and Soil Science*, **36(5)**, 922-928.

Mogili Ramaiah and Uma Maheswari T. (2018). Biology studies of tobacco caterpillar, *Spodoptera litura* Fabricius. *Journal of Entomology and Zoology Studies*, **6(5)**, 2284-2289.

Natikar, P.K. and Balikai R.A. (2017). Present status on bio ecology and management of tobacco caterpillar,

Spodoptera litura (Fabricius)/ – an update. *International Journal of Plant Protection*, **10(1)**, 193-202.

Ojumoola, O.A. and Omoloye A.A. (2022). Biology and morphometrics of the fall armyworm, *Spodoptera frugiperda* JE smith (lepidoptera, Noctuidae) in Ibadan, southwest Nigeria. *FUDMA Journal of Agriculture and Agricultural Technology*, **8(1)**, 351-363.

Rajendran, T.P., Birah A. and Burange P.S. (2018). Insect pests of cotton, In, *Pests and their management*, Springer Singapore, Singapore, 361-411.

Ramaiah, M. (2018). Studies on biology and morphometrics of important *Spodoptera* species. *Thesis M.Sc. (Agri.)*, Professor Jayashankar Telangana State Agricultural University, Rajendranagar, Hyderabad, Telangana, India. 73.

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.

Ramzan, M., Sajid Z., Sattar Z., Abbas D., Yaseen T., Mehmood S. and Yaseen I. (2020). Biological and Morphological Parameters of Armyworm, *Spodoptera litura* in Cabbage and Maize Plants under Laboratory Conditions in Southern Punjab, Pakistan. *Journal of Environmental Issues and Agriculture in Developing Countries*, **12(2)**, 83-91.

Sandhyarani, K. and Rani P.U. (2013). Morphometric and developmental consequences in *Spodoptera litura* due to feeding on three varieties of sweet potato plants (*Ipomoea batata*). *Phytoparasitica*, **41(3)**, 317-325.

Satiman, U., Tulung M., Pelealu J., Salaki C.L., Kolondam B.J., Tallei T.E., Emran T.B. and Pinaria A. (2022). Morphology, diversity and phylogenetic analysis of *Spodoptera exigua* (Lepidoptera, Noctuidae) in North Sulawesi by employing partial mitochondrial cytochrome oxidase 1 gene sequences. *Journal of Advanced Biotechnology and Experimental Therapeutics*, **5**, 136-147.

Selvaraj, S., Adiroubane D., Ramesh V. and Na rayanan A.L. (2010). Impact of ecological factors on incidence and development of tobacco cut worm, *Spodoptera litura* Fabricius on cotton. *Journal of biopesticides*, **3(1)**, 43.

Shalaby, M.M., Ghanim A.A., El-Serafy H.A. and El-Bialy F.M. (2025). Biological Studies on Three Lepidopteran Insect Pests Tomato Crop under Laboratory Conditions. *Journal of Plant Protection and Pathology*, **16(3)**, 181-185.

Sharma, S., Upadhayaya S. and Tiwari S. (2022). Biology and integrated management of tobacco caterpillar, *Spodoptera litura* Fab., A systematic review. *Journal of Agriculture and Applied Biology*, **3(1)**, 28-39.

Singh, P. and Kairon M.S. (2001). *Cotton varieties and hybrids*, Central Institute for Cotton Research, Nagpur, 15.