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Biology of *Spodoptera litura* (Fab.) associated with tomato crop in Mandi district of Himachal Pradesh

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Abstract

Biology of *Spodoptera litura* (Fab.) studied on tomato crop under laboratory conditions, consisted of four well defined stages namely, egg, larvae, pupa and adult. The female moths were observed to lay eggs (1365-1520 eggs per female) in batches of about 262-342 eggs/cluster on under surface of leaves with pre-oviposition, oviposition and post-oviposition period of 2.58 ± 0.38 , 3.46 ± 0.37 and 2.52 ± 0.37 days, respectively. The larvae passed through six instars to complete the larval development and the total larval period varied from 19.52 ± 3.54 days. The adult longevity of female varied from 13.38 ± 1.13 days, whereas, that of male ranging between 11.25 ± 1.02 days. The total life cycle of pest varied from 27-44 days.

Keywords: Biology, *Spodoptera litura* (Fab.) and tomato

Introduction

Tomato (*Solanum lycopersicum* L.) is one of the most popular vegetable crops and it is commercially cultivated in the world as well as in India. Tomato belongs to the family Solanaceae and is closely related to many commercially important vegetable crops such as potato, brinjal, chilli and capsicum. It is second most important remunerable solanaceous vegetable crop after potato either for local consumption or exportation (Sahu *et al.* 2013) [7], but it is first in the list of canned vegetables in the world (Singh 2005) [11]. Total global area under tomato is 4.73 million hectares with a production of 163.96 million tonnes (Anonymous 2016) [1]. In India, tomato is grown in an area of 778 thousand hectare with the production of 19397 thousand MT (Sharma 2019) [10]. In India, it ranks third in priority after Potato and second in the area as well as in production. The major tomato growing states in the country are Andhra Pradesh, Madhya Pradesh, Karnataka, Gujarat, Orissa, West Bengal, Chhattisgarh, Bihar, Telangana, Tamil Nadu, Uttar Pradesh, Maharashtra, Haryana and Himachal Pradesh. Among these states, Himachal Pradesh is one of the major tomato-producing state and is cultivated on 13,185-hectare area with a total production of 5,39,540 tonnes (Anonymous 2020) [2]. *S. litura* is most serious polyphagous pest and is known by different names like cluster caterpillar, cotton leafworm, tobacco cutworm and tropical armyworm in different parts of the world. In Himachal Pradesh, *S. litura* is also a major pest and the incidence of this pest has been observed to be more pronounced under polyhouse conditions as compared to the open environment where it has been found to cause economic damage on vegetables like capsicum, tomato, parthenocarpic cucumber etc. with infestation ranging between 25.0-75.0 percent (Vashisth 2009, Sood 2010 and Vashisth *et al.* 2012) [15, 12, 14]. The larvae of *S. litura* feed voraciously on leaves leaving behind midribs only. For first few days, larvae feed gregariously and then disperse to feed individually.

Materials and Methods

The experiments on biology of *S. litura* were conducted under laboratory condition in the School of Agriculture, Abhilashi University of Mandi, Himachal Pradesh during 2023. The biology of *S. litura* was studied under laboratory conditions on tomato leaves as food. The stock culture of *S. litura* was maintained in the laboratory for studying life cycle of the pest. The larvae of *S. litura* were collected from crops grown in the fields located in Mandi District of Himachal

Pradesh. These larvae were reared in plastic jars covered with a muslin cloth tied with the rubber band. The larvae were provided with the fresh leaves as a food. The leaves were changed daily till the larvae enter into pre-pupal stage after which they were shifted to jars containing soil for pupation. The emerged adults were kept for egg laying/oviposition in the jars supplied with a piece of crumpled paper at a cotton swab dipped in honey solution (20%) as a food to the adults. The egg masses laid on the paper and muslin cloth were collected daily with the help of moist camel hair brush. The eggs were examined daily for hatching and after hatching neonate larvae were provided with leaves as food. Neonate larvae were reared in plastic jars till adult formation for studying life cycle of the pest. Freshly laid eggs were collected with the help of a moist camel hair brush and 50 eggs in three replications were transferred to a plastic jar provided with a moist filter paper to prevent the desiccation of eggs. The period between the date of oviposition and date of hatching was considered as the incubation period and the number of eggs hatched was recorded to obtain the hatching percentage. One hundred fifty newly hatched larvae (10 per replication) were reared in plastic jars provided with tomato leaves as food. To ascertain the number of instars and their duration, observations on moulting were recorded daily. The duration of first instar was taken as the time period between larval emergence and first moulting. The duration of other instars was taken as the time period between two successive moults. Time gap between hatching of eggs and cessation of larval feeding was taken as total larval period. The time from cessation of larval feeding to the formation of pupa was considered as the pre-pupal duration, whereas the period between pupation and emergence of adult moths was taken as the pupal period. Ten pairs of newly emerged moths were taken and released in separate jars (one pair in each jar) for mating. In each jar, the adults were provided with 20 percent honey solution in a cotton swab as food and a crumpled paper for oviposition. Eggs laid daily were picked up and counted. The pre-oviposition, oviposition and post-oviposition periods were recorded in each mating jar. The period between the emergences of adult female moth to the start of egg laying was recorded as the pre-oviposition period. Time taken from initiation to cessation of egg laying by the female was considered as the oviposition period. Post oviposition period was counted as the time period between the last egg laying and death of the female. The adult longevity was recorded for both the sexes separately.

Results and Discussion

Results obtained from laboratory experiments biology of *S. litura* have been presented in Table 1. The freshly laid eggs were round in shape, pale green in colour when newly laid (Plate 1(a)) and before hatching, the eggs turned blackish in colour. Eggs were laid in masses piled in 2-3 layers and covered with brown scales detached from the abdomen of the females during oviposition. On an average, each egg cluster had around 262-342 eggs. In the present study the duration of incubation period varied from 2-6 days with an average of 3.45 ± 1.48 days. The hatchability of the eggs was recorded to vary from 86.52 to 95.55 percent. According to Nagal (2013) [6], the percent hatchability of eggs during different generations of *S. litura* under open environment and polyhouse conditions ranged between 73-100 and 76-100 percent, respectively which are in line with the present findings. Almost similar results were reported by Vashisth *et al.* (2012) [14] who recorded incubation period of 4.33 days on tomato, while Shakya *et al.* (2015) [9] reported it to be between 3 to 5 days. According to Tuan *et al.* (2015) [13] the incubation period of *S. litura* on cabbage was of 3.9 days. The *S. litura* had six larval instars. The newly hatched larva was cylindrical in shape. The newly hatched larvae were initially sluggish in nature which becomes active later (Plate 1(b)). The neonate larvae were pale green in

colour with dark black head having distinctly visible black hairs on the body and tiny black spot on first abdominal segment which later became yellowish green in colour. The 1st larval instar was completed with an average of 2.33 ± 0.38 days (2-3 days) before entering into next instar. The 2nd instar larvae appeared pale green in colour and were hairless. The body grew faster and as a result the body turned wider than head. The 1st and 2nd instar larvae were found scraping the chlorophyll of the leaves converting the lamina into a papery form. However, after moulting, the 2nd instar larvae at late stage of development started dispersing to feed individually. The duration of 2nd larval instar varied between 3-4 days with an average of 3.08 ± 0.68 days. The 3rd instar larvae changed their body colour to dark green with two dorsal black spots on the 1st abdominal segment and dark crescent shaped spots on the sides of the subsequent abdominal segment (Plate 1(c)). The spots on 1st segment were largest, followed by those on the 8th segment. The body was elongated and longer than 2nd instar. The duration of 3rd larval instar ranged between 4-5 days with an average of 4.3 ± 0.30 days. The 4th instar larva was dark green in colour with many yellow and green longitudinal stripes. Head and pro-thorax shield were dark green and crochets on pro-thorax were distinct. The duration of 4th larval instar ranged between 2-5 days with an average of 3.99 ± 0.57 days. The head of 5th instar larva was reddish brown and the tubercles and thoracic legs were black in colour. It was brown in colour with three thin yellow lines down the back, one in the middle and one on each side. The larva gets bigger in size and secretes green colored fluid when disturbed (Plate 1(d)). When disturbed, the caterpillar curls into a tight spiral with the head protected in the centre. The duration of 5th larval instar ranged from 3-6 days with an average of 3.93 ± 0.97 days to enter into pre-pupal stage. The 6th instar which indicated that the head capsule width increased with the larval growth. The sixth instar larvae stopped feeding, became inactive, shortened its length and transformed into a pre-pupa. The duration of 6th larval instar varied from 2-4 days with an average of 2.75 ± 0.79 days to enter into pupal stage. The total larval period varied from 16-27 days with an average of 19.52 ± 3.54 days. The results obtained in the present study on the duration of larval stages of *S. litura* are comparable with earlier study of Vashisth *et al.* (2012) [14] who also recorded six larval instars and reputed that the average duration of 1st to 6th larval instars and total larval period on tomato crop were 2.93 ± 0.80 days, 3.26 ± 0.70 days, 3.13 ± 0.35 days, 4.13 ± 0.52 days, 3.13 ± 0.35 days, 2.60 ± 0.63 days and 19.20 days, respectively, while average duration of 1st to 6th instar and total larval period on sweet pepper were 3.06 ± 0.46 days, 2.93 ± 0.80 days, 3.93 ± 0.46 days, 3.80 ± 0.77 days, 3.46 ± 0.64 days, 3.00 ± 0.53 days and 20.13 days, respectively. The newly formed pupa was yellowish white but later turned dark brown and finally blackish prior to adult emergence (Plate 1(e)). Pupation took place inside the soil in earthen cocoon. However, larvae also pupated in plastic jars used for mass rearing the insect under laboratory conditions. The duration of pupal period varied from 9-11 days with an average of 9.89 ± 0.77 days. Similarly, Vashisth *et al.* (2012) [14] recorded the total pupal period of 8.87 and 10.20 days on tomato and sweet pepper, respectively. Kumar and Bhattacharya (2019) [4] observed the total pupal period on tomato, cabbage, cauliflower and black gram as 6.4, 4.8, 5.4 and 9.6 days, respectively. Shahout *et al.* (2011) [8] reported pupal duration of 7.54 days on cabbage, while Gupta *et al.* (2015) [3] recorded pupal period of 9.37 days. The adults generally emerged during night hours and the females were found to live longer than the males. The adult moth was brown with a complex pattern of creamy coloured crisscrossing markings on the forewings (Plate 1(f)). The hind wings were silvery white in colour. The head, thorax, and abdomen are distinct. The antennae and legs are light brown. The female is generally bigger than the male. The adult longevity of female varied from 12-15 days with average of 13.38 ± 1.13 days whereas that of male varied from 10-13 days with an average of 11.25 ± 1.02 days, respectively. The total life cycle of *S. litura* varied from 27-44 days with an average of 33.31 ± 6.38 days.

Data on pre-oviposition, oviposition and post oviposition period of *S. litura* have been presented in Table 1, corresponding to these parameters; the average duration was recorded as 2.58 ± 0.38 days, 3.46 ± 0.37 days and 2.52 ± 0.37 days, respectively. The fecundity varied from 1365-1520 eggs per female. According to Latha *et al.* (2014) [5],

the pre-oviposition, oviposition period and post-oviposition period of *S. litura* lasted for 1-2, 3-7 and 1-2 days, respectively which supports the present findings. Similarly, Vashisth *et al.* (2012)^[14] recorded the adult longevity of male and female as 14.00 ± 1.09 and 12.20 ± 0.44 days, respectively on tomato crop, while adult longevity of male and female on sweet pepper was 11.13 ± 0.83 and 12.43 ± 0.53 days, respectively. They also reported the total life cycle of male and female as 46.16 and 44.78 days on tomato, respectively whereas total life cycle of male and

female on sweet pepper was 47.57 and 45.62 days, respectively, which are very close to present findings. The present results are in line with Shakya *et al.* (2015)^[9] who recorded the male and female longevity of 5-6 days and 9 days, respectively and also reported total life cycle of 42-46 days. The results obtained in the present study on total life cycle are comparable with earlier studies conducted by Latha *et al.* (2014)^[5] who reported that the total life cycle of male and female was 45.50 ± 1.58 days and 48.20 ± 2.10 days, respectively.

Table 1: Duration of different life stages of *S. litura* on tomato. The results obtained in the present study on total life cycle

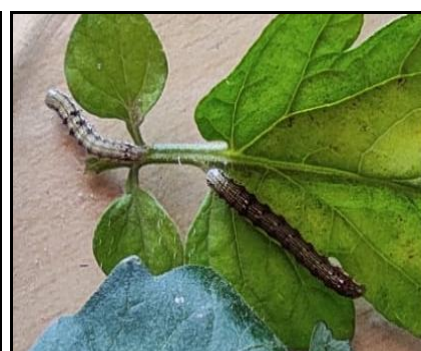
S. No.	Life Stages		Duration in days	
			Range	Mean $\pm$ SD
1	Eggs (incubation)		2-6	3.45 ± 1.48
2	Larval period	1 st instar	2-3	2.33 ± 0.38
		2 nd instar	3-4	3.08 ± 0.68
		3 rd instar	4-5	4.3 ± 0.30
		4 th instar	2-5	3.99 ± 0.57
		5 th instar	3-6	3.93 ± 0.97
		6 th instar	2-4	2.75 ± 0.79
3	Total larval period		16-27	19.52 ± 3.54
4	Pupal Period		9-11	9.89 ± 0.77
5	Pre-oviposition period		2-3	2.58 ± 0.38
6	Oviposition period		3-4	3.46 ± 0.37
7	Post-oviposition period		2-3	2.52 ± 0.37
8	Adult longevity	Female	12-15	13.38 ± 1.13
		Male	10-13	11.25 ± 1.02
9	Fecundity (No. of Eggs/female)		1365-1520 eggs	1440 ± 62.92
10	Total life cycle		27-44	33.31 ± 6.38



(a)



(b)



(c)



(a)



(b)



(c)

Plate 1: *S. litura* (a) Freshly laid eggs (b) Newly hatched larvae (c) Third larval instar (d) Fifth larval instar (e) Pupae (f) Adult

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