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Biology studies of tobacco caterpillar, *Spodoptera litura* Fabricius on castor (*Ricinus communis* L.)

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Abstract

Biology of Tobacco caterpillar (*Spodoptera litura* Fabricius) on Castor was carried out during 2018-19 at Department of Entomology, Chaudhary Charan Singh Haryana Agricultural University, Hisar. The total larval period of *S. litura* ranged from 12 to 22 days with a mean period of 15.6 ± 2.10 days. Pupation took place inside the soil (5 to 6 cm deep) provided in cylindrical glass jar. Mean pupal duration was 7.35 ± 0.80 days having a length and breadth of 14.20 ± 0.68 mm and 14.20 ± 0.68 mm, respectively. Total life cycle of *S. litura* varied from 21 to 37 days with an average period of 34.85 ± 3.44 days with a male-female ratio of 1:1.4 and adult emergence percentage was 86.66 per cent.

Keywords: Castor, biology, *Spodoptera litura*, larval period, male-female ratio

1. Introduction

In India, major oilseed crops of *Kharif* season are soyabean, groundnut, sesamum and castor. Castor (*Ricinus communis* L.) locally known as 'Arandi' is a non-edible oilseed crop which belongs to the family Euphorbiaceae. Castor oil and cake are two major products obtained from castor crop. Main use of castor crop is to extract non-edible oil from its seeds. Well drained sandy loam soils are suitable for its cultivation. The seed also contains ricin, a toxin which is present in lower concentrations throughout the plant. Major composition of seed is oil, constituting 50-55% which is unique in terms of a single fatty acid-ricinoleic acid (90%) (DOR, 2003) [5]. In India, total cultivated area under castor was 0.8 m ha with a production of 1.37 million tonnes and productivity of 1704 kg/ha during 2016-17. India exported 0.69 million tonnes of castor oil fetching Rs. 6730 crore in terms of valuable foreign exchange (Anonymous, 2018) [2].

More than 107 species of insects and six species of mites were recorded on castor at different stages of crop growth (Lakshminarayana and Raoof, 2005) [9]. Sarma *et al*, 2005 reported that most of the insect pests infesting castor crop either defoliators or sucking pests. The tobacco caterpillar, *S. litura* being polyphagous in nature is one of the most important insect pests of agricultural crops in the Asia. It is widely distributed throughout tropical and temperate Asia, Australia and the Pacific Islands (Feakin, 1973; Kranz *et al.*, 1977) [6, 8]. Tobacco caterpillar prefers castor as compared to mungbean and groundnut (Satyanarayana and Sudhakar, 1994) [14]. To undergo proper management of any insect-pest, a clear cut knowledge of its biology and population dynamics is must in order to target the most vulnerable stage.

2. Materials and methods

"Biology of Tobacco caterpillar (*Spodoptera litura* Fabricius) on Castor" was carried out during 2018-19.

The egg masses/larvae of *S. litura* were collected from the unsprayed field at Entomology research Farm, CCSHAU, Hisar. The collected larvae were brought to laboratory and reared in round glass jars. The larvae were fed on fresh and tender leaves of prevalent castor hybrid DCH-177. The leaves that were fed upon by the caterpillar were removed daily to maintain sanitation. The fifth instars were put in jar having soil and left for pupation. After pupation, the pupae were collected in petri-dishes with a layer of filter paper on the bottom. The male and female pupae after determining the sex were kept in separate jar covered with muslin cloth for emergence of adult. The male and female adult emerged out from pupae were collected and were released in a jar (having castor leaves) for mating and egg laying. Absorbent cotton dipped in 5 per cent honey solution was served as food for the adults. The leaves with freshly laid eggs were used for the study.

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The incubation period and number of larvae hatched were recorded. In order to determine the different larval instars, different instar durations and total larval duration, the newly hatched larvae were collected and reared on castor leaves. The individual larvae were transferred in petri dishes with the help of camel hair brush and were provided with fresh leaves. The leaves were changed every day in the morning. In order to determine the larval instars, the individual larva was observed daily for the exuviae as well as head capsule. Observations on number of instars, instar duration and total larval period were recorded. When the larvae were about to pupate, they were transferred in a jar having sieved moist soil at the bottom to facilitate the pupation. The pre-pupal period observations were taken every day in the morning during the larval development. Full grown larvae stopped feeding, become sluggish and darken in colour before entering into the pupal stage. These characteristics were used to know the initiation of the pre-pupal stage. The period from the larva stopped the feeding to entered into the soil for pupation was considered as pre-pupal period. The pupae were collected three days after pupation. Pupal period was calculated from the date of entry inside the soil to the date of emergence of imago. Observations on duration of various life stages i.e. egg, larva, pre-pupa, pupa and adult were recorded.

3.0 Results and discussion

The biology of *S. litura* on castor was carried out during August and September, 2018 at room temperature range of 28.50 ± 0.66 °C and 21.40 ± 0.81 °C with relative humidity of $66.39 \pm 1.66\%$ respectively.

3.1 Egg stage

The egg masses of *S. litura* were found laid on lower side of tender leaves of castor. The eggs were in cluster and covered with pale brown scales from abdominal tip of gravid female which look alike hairs. The arrangement of eggs was in group having 2 to 3 layers of eggs. The present findings are in conformity with the observation of Thomas *et al.* (1969)^[17] as he also recorded that eggs of *S. litura* were laid on under surface of tobacco, castor and banana leaves. Similarly Kumar and Jackson (2007) and Ramaiah and Maheshwari (2018) reported that the eggs of *S. litura* were covered by the scales from the tip of abdomen of female moths. Eggs were spherical in shape (Plate I) and pale greenish in colour. The present findings are in accordance with Cardona *et al.* (2007)^[3] as they also reported that round shaped eggs were laid in masses by *S. litura*. Prior to hatching covering (scales) of eggs was removed and it was seen that eggs turned black in colour showing developing head capsule of first instar. Incubation period varied from 2 to 4 days with an average mean of 2.95 ± 0.81 days. (Table 1). Similarly incubation period of 2.92 ± 0.03 days was recorded by Torreno (1985)^[18]. The diameter of egg varied from 0.41 mm to 0.42 mm with an average of 0.42 ± 0.01 mm (Table 3) which was more or less similar to findings of Ramaiah and Maheshwari (2018) who recorded diameter of eggs of *S. litura* was 0.41 ± 0.01 mm.

3.2 Larva

The newly hatched larvae feed gregariously on leaves surface by scraping, in early stage (Plate II). The severe feeding observed during night. The third, fourth and fifth instar larvae started feeding voraciously on leaves such that only mid ribs and veins left which is in close agreement with Chari *et al.* (1987)^[4] and Cardona *et al.* (2007)^[3]. Larvae pass through

five instars with every moulting feeding capacity of larvae increased. Same was recorded by Cardona *et al.* (2007)^[3].

3.2.1 First instar

First instar larva was pale greenish in colour having blackish head and small black dots on its body (Plate III). Small hairs on lateral sides of body were observed which shed down during moulting to second instar. hairs on lateral sides of body were observed which shed down during moulting to second instar. The above observations on first instar larvae colour and body are in close accordance with the observations made by Ramaiah and Maheshwari (2018) and Amaldoss and Hsue (1989)^[11]. Larvae were having mean body length of 1.45 to 1.60 mm with an average 1.00 mm and breadth varied from 0.22 to 0.26 mm with a mean of 0.25 ± 0.02 mm (Table 3). The duration of first instar lasted from 2 to 4 days having a mean period 3.10 ± 0.77 days (Table 1). More or less similar observations were recorded by Kanani (2013)^[7].

3.2.2 Second instar

The second instar larva was having faded yellow stripes along the back and the lateral sides (Plate IV) having light green body colour. The larvae were having mean body length of 3.91 to 5.10 mm with an average of 4.53 ± 0.43 mm, breadth ranged from 0.44 to 0.55 mm with a mean of 0.52 ± 0.04 mm (Table 3). The duration of second instar larvae ranged from 3 to 5 days with a mean period of 3.40 ± 0.67 days (Table 1). Similar observations were reported by Ramiah and Maheshwari (2018)

3.2.3 Third instar

The third instar larva was having black dots on each side of first and eighth abdominal segment (Plate V). The dotted black line was observed on lateral side of body and feed voraciously with fully developed mouth parts. The colour of larval body changed to light green to dark green. The length of third instar larvae varied from 10.63 to 13.09 mm with an average of 12.07 ± 0.82 mm while breadth varied from 1.46 to 1.55 mm with an average of 1.51 ± 0.04 mm (Table 3). The duration of third instar larvae were 3 to 5 days with a mean period of 3.75 ± 0.95 days (Table 1). All the observations were in close agreement with the findings of Kanani (2013)^[7].

3.2.4 Fourth instar

The fourth instar larva was having three bright coloured yellow stripes, one in middle and others two on lateral side of larval body (Plate VI). The larvae length ranged from 22.30 to 23.70 mm with an average of 23.03 ± 0.58 mm and breadth of 2.92 to 4.11 mm with a mean of 3.57 ± 0.43 mm (Table 3). The duration of fourth instar larvae varied from 2 to 4 days with a mean period of 2.45 ± 0.59 days (Table 1). Similar observations were observed by Kanani (2013)^[7].

3.2.5 Fifth instar

The fifth instar larvae were fully active and feeding voraciously on leaves resulting in feeding the whole leaves leaving only the mid rib. The length of fifth instar larvae varied from 37.60 to 38.20 mm with an average of 37.87 ± 0.33 mm. Similar observations were reported by Ramiah and Maheshwari (2018) that the length of fifth instar larvae varied from 37.40 to 38.04 mm with mean length of 37.72 mm. The breadth varied from 4.93 to 6.98 with an average of 6.03 ± 0.80 mm (Table 3). The duration of fifth instar larvae ranged

from 2 to 4 days having a mean duration of 2.90 ± 0.84 days (Table 1).

3.2.6 Total larval period

The total larval period of *S. litura* ranged from 12 to 22 days with a mean period of 15.6 ± 2.10 days (Table 1) which is close agreement to the observation of Thobbi and Srihari (1967) [16] who reported that larval duration on castor was 14 days. On contrary, Thomas *et. al.* (1969) [17] recorded that larval duration of *S. litura* on castor was 12.67 days.

3.3 Pre-pupa

In pre-pupal stage, fully developed larvae do not feed, become sluggish and enter inside the soil layer. Similar behavior was observed by Thomas *et.al.* (1969) [17]. The pre-pupal duration ranged from 1 to 2 days having a mean period of 1.50 ± 0.50 days (Table 1) which was more or less similar to observed by Soni *et. al.* (2001) [15] that per-pupal period was 2.06 days on castor.

3.3.1 Pupa

The pupation took place 5 to 6 cm deep inside the soil provided in cylindrical glass jar. The colour of pupae was light reddish (Plate VII) with the pupal duration varied from 6 to 9 days having a mean period of 7.35 ± 0.80 days (Table 1). Similar observation was observed by Patel *et al.* (1973) [11]. On contrary, Maghodia (2005) [10] observed the mean pupal period of *S. litura* on castor was 9.10 days. The mean length of pupae was 14.60 to 16.30 mm with an average of 14.20 ± 0.68 mm while the breadth ranged from 4.84 to 6.76 with an average of 5.46 ± 0.50 mm (Table 3) which is more or less equal to observed by Ramaiah and Maheswari (2018). The pupa was obdect and having 2 small spines at the tip of abdomen with seven pairs of spiracles (Plate VIII).

3.4 Adult

Adult female moths were having stout body than male moths. Same was stated by Kanani (2013) [7]. The female moth had brown tuft of hairs at the abdominal tip while it was absent in male (Plate IX). Similar appearance was observed by Amaldoss and Hsue (1989) [1]. The length of female moth ranged from 19.40 to 23.50 mm (21.57 ± 1.48 mm) with a wing span of 37.2 to 39.00 mm (37.88 ± 0.55 mm). The male moths were having a length of 18.30 to 21.50 mm (19.65 ± 0.94 mm) with a wing span of 36.80 to 38.00 mm with an average of 37.55 ± 0.34 mm (Table 3). The male moths were having a longevity of 6 to 8 days with an average of 6.75 ± 0.83 days while the female longevity varied from 7 to 9 days with a mean period of 8.15 ± 0.79 days (Table 1). More or less similar observations were taken by Ramaiah and Maheshwari (2018). The male moth was having ashy patch on apical margin of forewings while it was absent in female. Cardona *et al.* (2007) [3] observed that a bluish streak was present on the forewing of male moth. Kanani (2013) [7] observed that grey spot was present on forewings of male.

3.5 Sex ratio

The sex ratio of male and female is depicted in the Table 2 which shows that out of 26 adults there were 11 male and 15 female. Out of 30 pupae 26 emerged and remaining were deformed or did not emerge. The male-female ratio was 1:1.4. The adult emergence percentage was 86.66 per cent which is in close agreement with Kanani (2013) [7] who recorded the male-female ratio was 1:1.30.

3.6 Mating

Male and female adult moths were kept in a cylindrical jar covered with muslin cloth for mating. The mating took place during night. The behaviour of both was observed to be quiet until disturbed.

3.7 Total life span

The total life span of *S. litura* was 21 to 37 days with an average of 34.85 ± 3.44 days. The larval period ranged from 12 to 22 days with a mean period of 15.6 ± 2.10 days (Table 1). Similarly, Ramaiah and Maheswari (2018) recorded that life span of *S. litura* varied from 28.25 to 36.00 days with an average of 32.13 ± 5.48 days. On contrary, Kanani (2013) [7] recorded that total average life span of *S. litura* was 37.60 ± 2.08 days varied from 35 to 41 days.

Table 1: Development period of *S. litura* on castor hybrid DCH-177 during 2018-19

Stage		Duration (days)		
		Range (days)	Mean	S D
Incubation period		2.0-4.0	2.95	0.81
Larval period	I Instar	2.0-4.0	3.10	0.77
	II Instar	3.0-5.0	3.40	0.67
	III Instar	3.0-5.0	3.75	0.95
	IV Instar	2.0-4.0	2.45	0.59
	V Instar	2.0-4.0	2.90	0.84
Total larval period		12.0-22.0	15.6	2.10
Prepupal period		1.0-2.0	1.50	0.50
Pupal period		6.0-9.0	7.35	0.80
Adult longevity	Male	6.0-8.0	6.75	0.83
	Female	7.0-9.0	8.15	0.79
Life Cycle (egg to emergence of adult) : 21-37 days		34.85 ± 3.44 days		

* Each data is the mean of 20 observations



Plate I: (Isolated egg)



Plate II: (Gregarious feeding)



Plate III: (small dots on body)



Plate VII: (Reddish pupae)



Plate IV: (faded strips on body)



Plate VIII: (spiracles)



Plate V: (Third instar black dots)



Plate X: (Ashy patch male forewings)



Plate VI: (bright coloured strips)



Plate IX: (Female anal tuft of hairs)

Table 2: Adult emergence and sex ratio of *S. litura* on castor hybrid DCH-177 during 2018-19

Parameter	Number
Total pupae	30
Adult emergence	26
Adult emergence (%)	86.66
sex ratio (M:F)	1 : 1.4
Male	11
Female	15

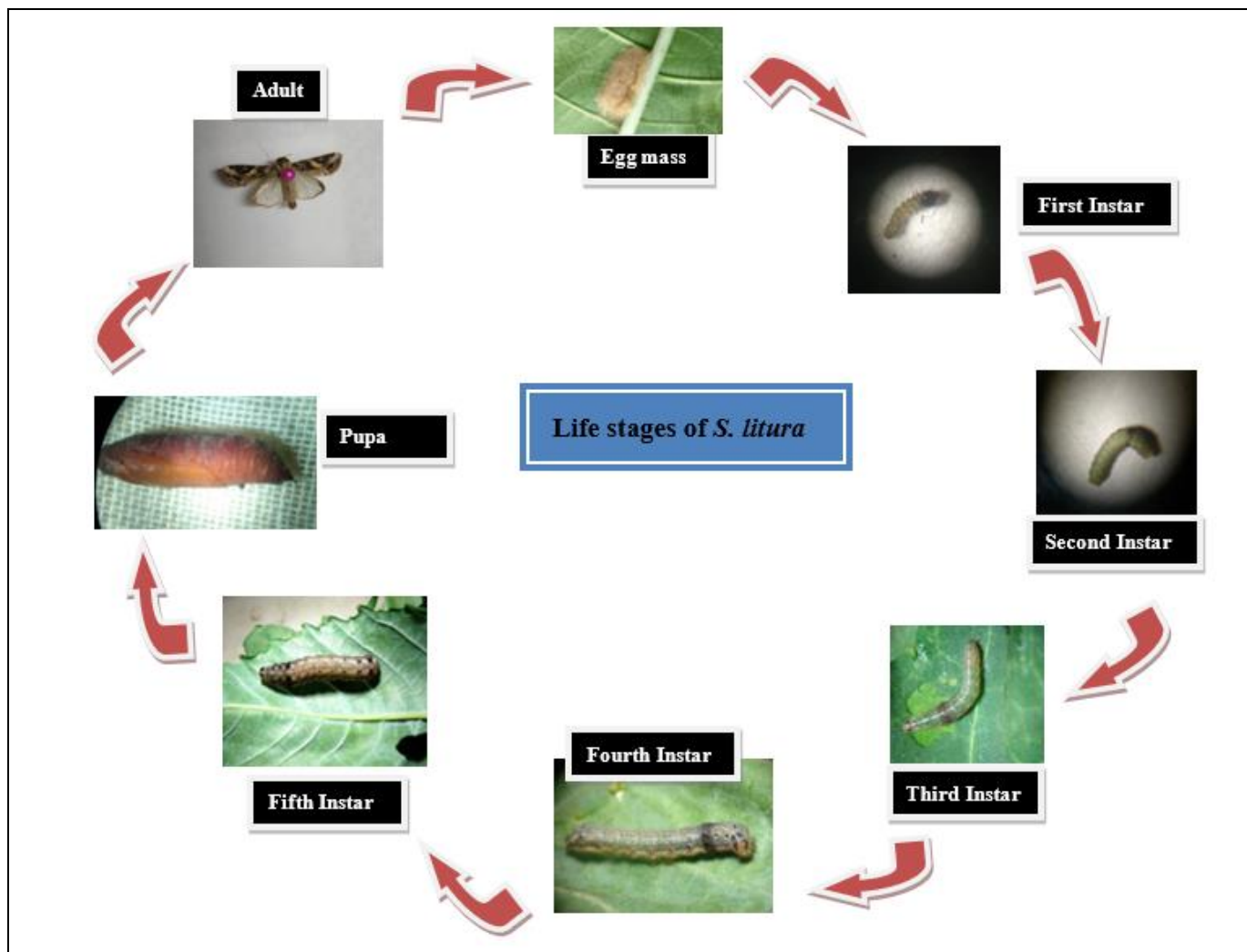


Table 3: Morphometric parameters of different life stages of *S. litura* castor hybrid DCH-177 during 2018-19

Stage	Length (mm)			Breadth (mm)			
	Range	Mean	S D	Range	Mean	S D	
EGG (diameter)	*0.41-0.42	*0.42	*0.01				
Larva	I Instar	1.45-1.60	1.53	0.06	0.22-0.26	0.25	0.02
	II Instar	3.91-5.10	4.53	0.43	0.44-0.55	0.52	0.04
	III Instar	10.63-13.09	12.07	0.82	1.46-1.55	1.51	0.04
	IV Instar	22.30-23.70	23.03	0.58	2.92-4.11	3.57	0.43
	V Instar	37.60-38.20	37.87	0.33	4.93-6.98	6.03	0.80
PUPA	14.60-16.30	14.20	0.68	4.84-6.77	5.46	0.50	
Adult	Male	18.30-21.50	19.65	0.94	**36.8-38.00	**37.55	**0.34
	Female	19.40-23.50	21.57	1.48	**37.2-39.00	**37.88	**0.55

n=20, *diameter of egg, **wing span

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