The Pharma Innovation Journal 2023; 12(3): 5249-5251

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; 12(3): 5249-5251

www.thepharmajournal.com
Received: 22-12-2022
Accepted: 24-01-2023

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Studies on the biology of tobocco caterpillar (*Spodoptera litura*) fabricus on cabbage

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Abstract
The current investigation was carried out during the year 2022-23 at Department of Agriculture, Tula's Institute Dehradun. During *Rabi* season, studies on the life cycle of *Spodoptera litura* under laboratory conditions was observed at 28 °C with 66% relative humidity. The study revealed that the pest passed through 4 stages *viz* egg, larva, pupa and adult. The incubation period lasted for about 2-4 days with an average of (5±0.57) days. The mean duration was (3.66±0.88), (4±0.57), (4.66±0.33), (4.33±0.88), (4.66±0.33) days for the 1st instar, 2nd instar, 3rd instar, 4th instar and 5th instar, respectively. Mean pupal duration was (12.33±3.84) days. The total life cycle from egg to emergence of adult was recorded; 8.33±0.88 (male) and 9.33±0.33 (female) days respectively.

Keywords: *Spodoptera litura*, pest, larva, egg, adult

Introduction
Cabbage (*Brassica oleracea* L. var. *capitata*.) belongs to the Brassicaceae family. It is an economically vital cruciferous vegetable, which is a rich source of Ca, P, Na, K, S, Vitamin A and dietary fiber. Major cabbage growing states in the country are Uttar Pradesh, Orissa, Bihar, Assam, West Bengal and Maharashtra. In India, cabbage is grown on a total area of 399 ha with an average production of 9095 MT. (Anonymous, 2019) [5]. In Uttarakhand, production is only 69.35 tonnes ha (Anonymous, 2021) [4]. Cabbage is attacked by many insects from sowing to harvesting *viz*, the tobocco caterpillar, cabbage butterfly, *Pieris brassicae.* Among these, the tobocco caterpillar is considered to be the most problematic (Chauhan *et al*, 2022) [8]. The tobocco caterpillar, *Spodoptera litura* (Fab.) is one of important polyphagous pest on crops, distributed throughout South and Eastern world, infesting 112 species of plants belonging to 44 families, of which 40 species were reported from India. It is widely distributed throughout tropical and temperate Asia, Australia and the Pacific Islands (Feakin, 1973; Kranz *et al*., 1977) [23, 24]. Though it is a serious pest of tobocco, the major host plants include tobocco, cotton, groundnut, castor, chilli, cabbage, tomato and sunflower. (Ramaiah *et al*., 2018) [16]. Biological studies is one of most important tools in pest management as they reveal the most opportune and vulnerable stages of the insect species (Ashwini *et al*., 2016) [5]. To develop pest forecasting models, the number of larval instars and other information about insect biology are useful. In order to identify and manage *Spodoptera. litura*, studies on biology, morphometrics, and growth will be helpful.

Material and Methods
The Biology of Tobacco Caterpillars
An experiment was conducted at Tula's Institute, Dehradun, in *Rabi* season in 2023. The culture of tobocco was maintained under laboratory conditions on cabbage plants and different stages were reared as per the method given below. The eggs were collected from Agriculture Farm Tula's Institute and brought into the laboratory, placed in a BOD incubator calibrated at 28 C coupled with 66% relative humidity. In December, cabbage began laying eggs. Eggs were found in clusters on the lower sides of the leaves of the plants. During incubation, the eggs were placed over moist filter paper in Petri dishes. 10 newly hatched larvae were transferred singly to cabbage leaves free from insecticide kept in three petri-dishes which are lined with moist filter paper and provided with fresh leaves. The petri plates were cleaned of excrement and food residue every day. A change of filter paper and food was made every two days.

Care was taken to handle the larvae to avoid any bacterial infection. As adults emerged, the culture had been covered with muslin cloth and continuously supplemented with 10% honey solution.

Morphological observations

Observations were made at 12 hour intervals of growth, moulting, passing into next instar, and the number of larvae laid per female. From these observations, incubation period, duration of instar, pupal period, total larval period, adult longevity as well as total life cycle were recorded as described below. The description of various stages namely egg, larva, pupa and adult is detailed below.

Statistical Analysis

Data collected on the size of different stages of insect, egg, larva, pupa and adult was analyzed for calculating mean and standard deviation.

Result and Discussion

Biology of *Spodoptera litura* was studied on cabbage under laboratory conditions during December and January. Here is a detailed description of the various stages, namely egg, larva, pupa, and adult.

The incubation period

Eggs were covered with yellowish brown hairs and the hairs seen earlier were present on the abdomen of the adult. Eggs were spherical in shape and yellowish creamy in colour. Eggs were observed hatching in the early morning hours, the colour of the egg mass changed from yellow to dark black as the eggs hatched (Ramaiah *et al.*, 2018) [16]. An egg incubates for an average of (5±0.57) days. The results of our experiments are in accordance with the studies made by Ramaiah and Maheswari (2018) [16] who observed that the incubation period of *S, litura* under laboratory conditions varied between 3 days.

The larval period

The tobacco caterpillar passes through five larval instars to become adults. The neonate larvae were pale green in colour with distinctly visible black hairs on the body. A tiny black spot on first abdominal segment later became yellowish green in colour. The duration of the first instar lasted for (3.66±0.88) days. The second instar larvae appeared pale green in colour and hairless, having a light green body colour. Larvae in their second instar at a late stage of development. Duration of the second instar lasted for (4±0.577) days. The third instar larvae changed their body colour to dark green with two dorsal black spots on the first abdominal segment. The larval body's color changed from light green to dark green. The third instar occupied a period of (4.66±0.33) days. Fourth instar larvae had three yellow stripes, with the central band becoming bright orange and the two lateral bands becoming yellow. This instars lasted about (4.33±0.88) days. After the fourth instar larvae moulted, the larvae turned dark blackish brown with three lines or bands. Each lateral yellow band exhibited black spots from anterior to posterior. During their fifth instar, the larvae were fully active and they fed quickly on leaves leaving only the midribs behind. The larval period of the fifth and sixth instars lasted approximately 4.66 times, for an average of 0.33 days. The present work regarding the larval period was in line with the findings reported by Deepak *et al.*, 2020. They reported that there are five larval instars which completed their development in 12-22 days.

The pupal period

Pupae appeared pale yellowish, but later became dark reddish in colour. The pupal period lasted for 7-8 days with an average of (12.33±3.84) days.

The adult longevity

The adult moth was brown with a creamy colour pattern and crisscross markings on the forewings. The male had a prominent white band on the forewings. Male adults tend to be somewhat brighter than female adults. The female lived longer with a lifespan of between (9.33±0.33) days and the male lived longer with a lifespan of between (8.33±0.88) days. These findings regarding the adult period were in line with the similar work done by Ramaiah and Maheshwari (2018) [16].

The total development period

The period from egg to adult emergence is known as the total development period. Development period from egg to adult emergence varies from (34.66±11.83) days with an average of 28-32 days. It is similar to the findings of Ramaiah and Maheshwari (2018) [166] who reported that the total development period ranged from 28-36 days.

Table 1: Duration of life cycle of *Spodoptera litura* on cabbage crop in (Dec- Jan) 2023

Developmental stages	Range (days)	Mean duration in days ± S.E (m)
Incubation period	2.0 - 4.0	5±0.57
No. of larval instars		
Ist instar	2.0 – 3.0	3.66±0.88
2nd instar	2.0 – 3.0	4±0.577
3rd instar	3.0 – 4.0	4.66±0.33
4th instar	2.0 – 3.0	4.33±0.88
5th instar	2.0 -3.0	4.66±0.33
Total larval period	11 – 16.	14.33±4.17
Pupal period	7.0 -8.0	12.33±3.84
Adult longevity		
A) Male	6-7	8.33±0.88
B) Female	7-9	9.33±0.33
Total life cycle	28-36	34.66±.11.83
S.E (d)	_	5.651
C.D(0.05)	_	11.79

Data based on the mean duration in days of 10 individual on cabbage crops.

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