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Biology and morphometry of cabbage headborer (*Hellula undalis* Fab.) (Pyralidae: Lepidoptera)

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Abstract

Cabbage (*Brassica oleracea* var. *capitata* L.) is cultivated extensively in different parts of India. However cabbage growers suffer from severe attack of headborer *Hellula undalis* (F.), at early stage of crop growth. Therefore, attempt was made to study the growth and development of this noxious insect during *rabi* 2022 under laboratory conditions (25 °C±2 and 60% RH) at Department of Agricultural Entomology, College of Agriculture, Raichur. The results revealed that incubation period was 2.3±0.48 days. Length and breadth of egg was 0.43±0.01 mm and 0.31±0.01 mm, respectively. The duration of 1st, 2nd, 3rd and 4th larval instars was 3.3±0.48, 5.0±0.82, 5.3±0.48 and 6.2±0.68 days, respectively. The total larval duration was 19.3±2.2 days. The prepupal and pupal period was 2.4±0.516 days and 11.3±1.4 days respectively. The adult longevity of male and female was 4±0.87 days and 5.7±0.70 days, whereas the pre-oviposition, oviposition and post-oviposition periods were 2.3±0.47, 2.4±0.49 and 1.3±0.46 days, respectively. The average fecundity was 100.06±11.39 eggs/ female.

Keywords: Cabbage, *Hellula undalis*, morphometrics, fecundity

Introduction

Cabbage, *Brassica oleracea* var. *capitata* L., is one of the most important cruciferous winter vegetables grown extensively in tropical and temperate regions of the world. Cabbage is infested by many insect pests of which, *Plutella xylostella* (L.) (Lepidoptera: Plutellidae), *Spodoptera litura* (F.) (Lepidoptera: Noctuidae), *Pieris brassicae* (L.) (Lepidoptera: Pieridae) and *Hellula undalis* (F.) (Lepidoptera: Pyralidae) cause appreciable loss (Bhalani, 1984) [2]. The cabbage webworm or cabbage headborer, *Hellula undalis* a native of Europe, has been one of the most serious pests of brassicas and other crucifers in warm regions worldwide (Waterhouse and Norris, 1989) [12]. Its serious outbreaks have been reported in some Asian countries including India (Srihari and Satyanarayana, 1992; Dhawan and Matharu, 2011) [9, 4], Malaysia (Sivapragasan and Chua, 1997; Sivapragasan, 2005; Zulfiquar and Malik, 2017) [8, 7, 13] and Vietnam (Tran *et al.*, 2018) [10]. The larvae of *H. undalis* initially bore into the stem of growing shoots, later instars mine the leaves and leaf stems. It makes a web of silk around the feeding area which accumulates frass. Feeding damage by a single larva boring through the growing shoot of the cabbage plant in the pre-heading stage could result in either death or production of multiple heads which are not marketable (Sivapragasan, 2005) [7]. Previous studies indicated that its biology has been studied to some extent in Japan by Watanabe (1927) [11] and in Morocco by Bouhelier and Hudault (1935) [3], but practically little work has been reported from India (Ayyar, 1940) [1]. Due to lack of information on the life cycle and information on morphometries of this pest, the present work has been undertaken.

Material and Methods

The biology of cabbage head borer was studied during 2021-22 under laboratory condition (25 °C and 60 per cent relative humidity) in the Department of Agricultural Entomology, College of Agriculture, Raichur, Karnataka, India. The larvae were collected from cabbage fields and daily fresh cabbage leaves were provided as food. The pupae were kept in a rearing cage for adult emergence. As soon as adults emerged, they were provided with 10 per cent honey solution. Small seedlings were kept in the rearing cage for the adult egg laying. The duration of eggs was studied on the basis of 20 eggs in a Petri plate having moist sponge covered with blotting paper for duration of 12 hrs. The duration of larval stages was determined by releasing 20 neonates, separately in petri plates, larvae were provided with a small leaf for feeding and covered with another leaf of the same size and food was changed daily. The observation on duration of different larval instars was recorded using a magnifying hand lens (15X).

The pre-pupal period was characterized by the contracted body and sluggishness of the larvae and was studied on the basis of 20 larvae. For observations of pre-oviposition, oviposition and post-oviposition periods, ten freshly emerged pairs were separately released in rearing cages.

The adults were provided with small sapling for egg laying and 10 percent honey solution was provided as food. After the start of egg laying, the females will be transferred daily to new rearing cages for recording fecundity, pre-oviposition, oviposition, post-oviposition period and longevity till they died. The pupae were kept for adult emergence and observed at an interval of 12 hours to record the time of emergence. The adults from laboratory reared culture will be sorted out into males and females on the basis of the abdomen, which is usually broader in females than males. The length and breadth of eggs, different instars larva, pupa and adult were measured by using a stereoscopic binocular microscope.

Results and Discussion

Egg period

The moth laid eggs singly on the lower surface of the leaves and tender parts of the lower stem. The newly laid eggs were round with a flattened base, light white and shining. When they were about to be hatched, their colour changed to a bright pinkish colour. The incubation period ranged from 2.0 to 3.0 days, with a mean of 2.30 days (Table 1). The average length and width of the egg were 0.43 mm and 0.29 mm, respectively (Table 2).

Larval instars

During the larval period, the larva moulted three times and thus had four instars. The duration taken from the first larval instar to the last larval instar and their morphometric studies are presented and discussed below (Table 1 and 2).

First instar larva

The newly hatched larvae were tiny, delicate, soft, active and light pink, black head capsule with short tiny hairs over the body. They feed on tender stem by webbing and making holes in the tender petioles of leaves. The duration of first instar larva ranged from 3.0-4.0 days with an average of 3.30 days (Table 1). The length and width of the larva ranged from 3.45-3.7 mm and 0.42-0.46 mm respectively. The average length and width of the larvae ranged from 3.56mm and 0.44mm, respectively. The length and width of head capsule ranged from 0.162-0.165 mm and 0.182-0.188 mm respectively. The average length and width of the head capsule was 0.1638 mm and 0.185 mm respectively (Table 2).

Second instar larva

The second instar larva was creamy pinkish. In this instar, the body is soft with setae all over the body with light brown longitudinally stripes. Initially, it feeds on leaves by scrapping green tissues and later makes small holes in leaves by feeding. The duration of second instar larvae ranged from 4.0-6.0 days with a mean of 5 days (Table 1). The length and width of the larvae ranged from 9.0-9.30 mm and 1.45-1.56 mm respectively. The average length and width of larvae were 9.16 mm and 1.51 mm respectively (Table 2). The length and width of head capsules ranged from 0.286-0.289 mm and 0.300-0.302 mm respectively. The average length and width of head capsules was 0.287 mm and 0.301 mm respectively (Table 2).

Third instar larva

The larva was characterized by pinkish-brown longitudinal four to five stripes which was distinct and with the black head capsule. During this instar, the larva starts feeding actively by defoliating the leaves. The duration of the third instar larvae ranged from 5.0-6.0 days with the mean of days (Table 1). The length and width of the larvae ranged from 15.32-16 mm and 2.88-2.98 mm respectively. The average length and width of the larvae were 15.76 mm and 2.94 mm respectively (Table 2). The length and width of the third instar head capsule ranged from 0.50-0.51 mm and 0.47-0.48 mm respectively. The average length and width of the head capsule was 0.51 mm and 0.47 mm respectively (Table 2).

Fourth instar larva

The last instar larva is creamy yellow and has five distinct pinkish brown longitudinal stripes dorsal, one at mid-dorsal and other two at dorso-lateral on either side. Just below the lower dorso-lateral stripes, there are brownish circular minute spiracles. Small setae, borne on minute tubercles, are found sparsely situated over the body. The larvae usually scrap and feed on chlorophyll content. The duration of the fourth instar larva ranged from 5.0-7.0 days with a mean of 6.2 days (Table 1). The length and width of the larva ranged from 21.08-22.0 mm and 4.2-4.32 mm respectively. The average length and width of the larvae were 21.95 mm and 4.25 mm respectively. The length and width of the fourth instar head capsule ranged from 0.64-0.65 mm and 0.62-0.68 mm respectively. The average length and width of head capsule was 0.645 mm and 0.642 mm respectively (Table 2).

Total larval period (days)

The total larval period of *Hellula undalis* ranged from 17.0-23.0 days with an average of 21.67 days (Table 1).

Pre pupa

At the end of the fourth instar, the larva becomes inactive, cessation of feeding and contracted its body with reduced size and sluggishness of the larva, which lasted about 2.0-3.0 days with an average of 2.4 days (Table 1).

Pupa

Pupation occurs between the webbed leaves, after a few hours of pupation, the pupa gets much contracted. It turns a dark brown colour before emergence.

Male pupa with short slit, located on the ventral side of the ninth abdominal segment. The length and width of the male pupae ranged from 16.7-16.9 mm and 2.40-2.60 mm, respectively. The average length and width of the male pupae were 16.82 mm and 2.48 mm, respectively (Table 2).

Female pupa with longitudinal suture, located on the ventral side of the eighth and ninth abdominal segment. The length and width of the female pupae ranged from 16.8-16.9 mm and 2.20-2.35 mm, respectively. The average length and width of the female pupae were 16.88 mm and 2.26mm, respectively (Table 2).

Adult

Adult moths typically emerge at night. The pupal covering is torn at the time of emergence and the moth gently wriggles out of the longitudinal slit. The forewing of the male moths contains wavy grey markings, while the hind wings are pale and dusky. However, the markings on the newly emerging females are considerably lighter than those on the male. The terminal section of the abdomen is long and pointed in

females whereas it is rather blunt in males.

Male adult longevity

Longevity of male adults ranged from 3.0-5.0 days with an average of 4.0 days (Table 1). The length and width of male moths measured in a range of 7.6-7.98 mm and 1.42-1.49 mm respectively, with an average of 7.92 mm length and 1.45 mm width. Adult male moth lives shorter than female (Table 2).

Female adult longevity

The longevity of female adults ranged from 5.0-7.0 days with an average of 5.7 days (Table 1). The length and width of female moths measured in a range of 8.03-8.06 mm and 1.1615-1.1612 mm respectively, with an average of 8.04 mm length and 1.61 mm width. Adult female moth lives longer than male (Table 2).

Pre-oviposition period

The pre-oviposition period ranged from 2.0-3.0 days with an average of 2.3 days (Table 1).

Oviposition period

The oviposition period ranged from 2.0-3.0 days with an average of 2.4 days (Table 1).

Post-oviposition period

The post-oviposition period ranged from 1.0-2.0 days with an average of 1.3 days (Table 1).

Fecundity

The average number of eggs was 100.06 with a range of 100-120 eggs (Table 1).

Egg hatchability

The egg hatchability percentage ranged from 72.3-76.03% with an average of 74.06% (Table 1).

Total life cycle

The total life cycle of *Hellula undalis* ranged from 35.0-42.0 days with an average of 38.7 days (Table 1).

Table 1: Biology of head borer, *Hellula undalis* on cabbage

Stages	Observation in days	
	Mean±S.D.	Range(days)
EGG (days)		
Incubation period	2.3±0.483	2.0-3.0
Larva (Days)		
I Instar	3.3±0.483	3.0-4.0
II Instar	5.0±0.942	4.0-6.0
III Instar	5.3±0.483	5.0-6.0
IV Instar	6.2±0.918	5.0-7.0
Total larval period	21.67±1.29	17.0-23.0
PUPA (days)		
Pre-pupal period	2.4±0.516	2.0-3.0
Pupal period	11.3±1.4	10.0-11.0
Adult (Days)		
Male adult longevity	4±0.87	3.0-5.0
Female adult longevity	5.7±0.70	5.0-7.0
Total life cycle	38.7±1.86	35.0-42.0
Pre- oviposition period	2.3±0.47	2.0-3.0
Oviposition period*	2.4±0.49	2.0-3.0
Post-oviposition period	1.3±0.46	1.0-2.0
Fecundity**	100.06±11.39	100-120
Egg Hatchability (%)	74.06±0.64	72.3-76.03

Note: n=30; *Mean of 5 females; ** in numbers

Table 2: Morphometrics of different life stages of *Hellula undalis*

Life stages	Length(mm)		Width(mm)	
	Mean±S.D.	Range	Mean±S.D.	Range
EGG	0.43±0.01	0.4-0.44	0.29±0.012	0.28-0.32
Larva				
I Instar	3.56±0.08	3.45-3.7	0.44±0.015	0.42-0.46
II Instar	9.16±0.12	9.0-9.30	1.51±0.032	1.45-1.56
III Instar	15.76±0.23	15.32-16	2.94±0.041	2.88-2.98
IV Instar	21.95±0.30	21.08-22.0	4.25±0.045	4.20-4.32
Head capsule length(in mm)			Head capsule width (in mm)	
I moult	0.1638±0.001	0.162-0.165	0.185±0.001	0.182-0.188
II moult	0.287±0.0008	0.286-0.289	0.301±0.0006	0.300-0.302
III moult	0.51±0.003	0.500-0.513	0.475±0.005	0.47-0.48
IV moult	0.645±0.005	0.64-0.65	0.642±0.016	0.62-0.68
PUPA				
MALE	16.82±0.07	16.7-16.9	2.48±0.07	2.40-2.60
FEMALE	16.88±0.04	16.8-16.9	2.26±0.05	2.20-2.35
Adult				
Male	7.924±0.11	7.6-7.98	1.45±0.02	1.42-1.49
Female	8.04±0.009	8.03-8.06	1.61±0.001	1.615-1.612

Note: n= 10; S.D. – Standard Deviation

Our results are in conciliation with the findings of earlier workers Peter *et al.* (1987) ^[6], Labh *et al.* (1990) ^[5] and Dhawan and Matharu (2011) ^[4] who reported that the egg incubation period was 2.3±0.48 days. Length and breadth were 0.43±0.01 mm and 0.31±0.01 mm, respectively. The total larval duration was 19.3±2.2 days, the prepupal period 2.7±0.82 days and the pupal period 17.7±0.82 days. The full-grown larvae measured 22.09±0.71 mm in length and 4.32±0.46 mm in breadth. The adult longevity of male was 3.8±1.0 days and female was 5.7±1.3 days, and the pre-oviposition, oviposition and post - oviposition periods were 1.8±0.42, 3.7±0.63 and 1.2±0.38 days, respectively. But earlier studies did not provide the detailed morphometrics data. In the current study, morphometrics data of various life stages are provided with images using stereoscopic binocular microscope.

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Conclusion

The above biological parameters studies revealed that the head borer could complete a generation in 35 to 42 days. Also biological studies of this pest on other alternate host need to be studied and the effect of this noxious insect is seen at early stage of crop which leads to double head formation. There is a need of an integrated approach in wake of the arising concern for the interest of human safety, environmental protection, and sustainability and incidence of increased resistance. Hence proper management strategies need to be implemented during early stage of crop growth. Such approaches result into high yields and increase the profit.

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