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Life cycle of cabbage caterpillar, *Pieris brassicae* Linn. (Lepidoptera: Pieridae) on cabbage leaves in Talwandi Sabo (Punjab)

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Abstract

Study on different biological parameters of cabbage caterpillar, *Pieris brassicae* was carried out in Guru Kashi University, Talwandi Sabo (Punjab) during 2018-19. The average incubation period of eggs was recorded as 4.3 days. The freshly laid eggs of the caterpillar were light yellow that turned grayish black prior to hatching. The average duration different larval instars, namely 1st, 2nd, 3rd, 4th, and 5th, lasted for 4.6, 5.9, 3.5, 3.1 and 4.3 days, respectively. The full grown larvae stopped feeding before pupation, which took place on rough surface i.e. muslin cloth. Total larval and pupal periods were recorded as 21.45 and 10.95 days, respectively. The females were longer lived than the males with average longevity of 9 and 8.15 days, respectively. The male to female sex ratio was 1:1.56. The fecundity of female was observed to be 163 eggs/female and the per cent hatchability 96.82. Larval and pupal survival was observed as 87 and 95 percent, respectively. Total life cycle of male and female was 45 and 46.5 days respectively. On an average, the 1st, 2nd, 3rd, 4th and 5th instar larvae measured 6.45, 13.3, 21.65, 33.65 and 40.75mm in length, respectively. The larval width of the corresponding instars were 1.0, 2.0, 2.6, 3.75 and 4.75mm in breadth. The length and breadth of pupa were measured as 25.65±0.48 and 6.55±0.51mm, respectively and the body lengths of adult male and female were 21.95 and 22.8mm respectively. The breadth of fore and hind wings of male was 30.6 and 25.6mm and those of females was 32.25 and 26.7mm, respectively.

Keywords: Cabbage, *P. brassicae*, instar, parasitization and moulting

Introduction

Vegetables play an important role in the balanced diet of human because they contain the components of balanced diet. India secures rank second in vegetable production after china contributing 11.4% of world's total vegetable production [14]. Cabbage (*Brassica oleracea* var. *capitata*) is an important cruciferous crop genus *Brassica* and is known to originate in south and western coast of Europe [8]. After China, India is the largest grower of cabbage in world [14]. During 2017-18, in India, the annual production of cabbage was about 90lac MT with productivity 22.7 MT/ha and cultivated in an area of 3.9 lakh ha. Among all vegetables grown in Punjab cabbage occupied an area 6.24 thousand ha with an average yield of 184.7q per ha during 2017-18 [2]. Bearing leafy green heads the cabbage is used as salad, vegetable, food (cooked / raw) as well as for medicinal purposes. Raw cabbage contains vitamins C, B1, B2 and B3, along with iron, calcium and potassium [11]. Cabbage also contains glucosinolates and is known anti-cancer and antioxidant properties, due to presence of tannins and flavonoids [12]. Biotic stresses in the form of diseases and insect-pests are two major constraints in vegetable production, more than 40% annual losses have been reported to be caused by different insect pests [1]. A complex of 23 beneficial and harmful insect-pests is found in cabbage crop [14] and the cabbage caterpillar is the most destructive pest of cruciferous crops [3]. Newly hatched larvae feed gregariously by lacerating the leaf surfaces of cabbage plants, while the full grown larvae get scattered and feed isolated and complete defoliation occurs in severe infestations. In recent years the caterpillar has become a major constraint in production of *Brassica* crops in this region. Hence the studies on its various biological parameters was initiated in the department of Entomology at Guru Kashi University, Talwandi Sabo, Bathinda (Punjab).

Materials and Methods

The cabbage crop was planted at research farm of the University for obtaining leaves for rearing larvae. Adults of *Pieris brassicae* were collected by using insect nets and they were then released on to potted cabbage for egg laying. Cotton swabs soaked with honey solution (10 %) were hanged inside the caged plants, to serve as food for the adults. The eggs were laid by the female butterflies on leave, which were used for studying biology of *P. brassicae*.

The eggs were observed daily to observe hatching of larvae from them. The freshly hatched larvae were picked up gently with the help of camel hair brush and were transferred into round plastic jars (4" x 8"), containing fresh cabbage leaves. The food was changed and plastic jars were cleaned on daily basis. To study duration of different larval instars, observations on molting were recorded daily. The period between date of pupation and adult emergence was taken as the pupal duration and the adult longevity was calculated between the dates of adult emergence and death. Total life cycle recorded from egg to death of adult. Parasitization of cabbage caterpillar by apanteles was studied on field collected 4th instar larvae. To record larval survival percentage, pupal survival percentage, percent parasitization 50 specimens were tested in 5 jars each contained 10 specimens. Similarly, 50 pupae were placed in 5 jars each jar contained 10 pupae to calculate sex ratio and adult emergence percentage. Male and female butterflies emerged from pupae were counted to obtain sex ratio. To record percent hatchability of eggs number of eggs hatched into larvae from 50 marked eggs were counted. Morphometric observations on various stages of the test insect were taken using graph paper. The larval length was measured from head to the anal end and the breadth was measured at middle part of the body, across dorsal region of larva. Similar observations were made on pupae. The body length of male and female adults was measured from head to the posterior end of abdomen. Breadth of fore and hind wing was measured across the wing expanse from ptero-thorax to apical margin in each case.

Results & Discussion

Egg: The freshly laid eggs were yellow in color and their tips turned grayish black before hatching. The shape of eggs was similar to that of bullet of gun or maize cob with longitudinal ridges. The eggs were glued to underside of the leaf surface (Plate 1). The females continued laying eggs in clusters for 2 – 3 days on under surface of cabbage leaves. Freshly laid eggs were light yellow in color and glued to the leaves^[9, 13]. The total egg incubation period ranged from 3-6 days with an average of 4.3 ± 1.08 days (Table 1). Incubation period was 4.6 days^[6] and 4.80^[10] days. Female butterflies laid eggs in clusters on underside of leaves. The fecundity or eggs laid per female ranged from 110 – 220 eggs with an average of 163.45 ± 33 (Table 1). The results are in line with Fecundity has been reported as 164 eggs / female^[5]. The hatching percentage of eggs ranged from 90.90 – 100 with an average of $96.82 \pm 2.93\%$. The hatching percentage of eggs was 98 and 97 percent on cabbage and mustard, respectively^[9].

Larva: The larva of *P. brassicae* (Linn.) underwent four molts, comprising five larval instars. The newly hatched larvae were cylindrical in shape and light yellow in color, the head slightly black and body covered with hairs. The body color of third instar larvae greenish, the color changing dark greenish in 4th instar. Numerous hairs were present on fifth

instar larvae. The thorax bearing three pairs of thoracic legs and the abdomen bears five pairs of pro legs on 3rd, 4th, 5th, 6th and 10th abdominal segments. The average duration of 1st, 2nd, 3rd, 4th, and 5th instar larvae was 4.6, 5.9, 3.5, 3.1 and 4.3 days respectively. Investigations on total larval period revealed that total larval period ranged from 19-24 days with an average of 21.45 ± 1.19 days (Table 1). Duration of 1st, 2nd, 3rd, 4th, and 5th instar larvae was 4.09, 4.29, 3.77, 3.60 and 3.41 days on *Brassica napus*^[7].

Pupa: The full grown larvae stopped feeding and turned into pupae that were whitish to greyish in color having numerous spots (Plate 1). There was a lateral ridge along both side and similar ridge arising from middle of anterior which extended over whole dorsal region of pupae. There was a cross ridge in the middle of the body and small spike like growth on dorso-lateral sides of the body. The full grown larvae got attached to muslin cloth of rearing jars, for pupation. Total pupal period ranged from 10 – 12 days with an average of 10.95 ± 0.75 days. Pupal period was 9.4 days on cabbage^[9].

Adult: The adults of cabbage caterpillar are butterflies pale white in color. The wings were white with dark brown tips on the forewings in case of both males and females. One pair of brownish black spots was present on dorsal side of each fore wings of females while absent in males (Plate 1). Two black circular spot found on dorsal side of each forewing of female^[5]. The male to female ratio was found to be 1:1.56. Female: male sex ratio was recorded 1.5:1^[8]. Studies on adult longevity of male and female revealed that male adult lived for 7- 9 days with an average of 8.15 ± 0.58 days. Female butterflies lived for 8-11 days with an average of 9 ± 0.72 days (Table 1). The results clearly showed that female lived longer than male butterflies. Longevity of male and female was 10.3 and 8.3 days, respectively^[9]. Total life cycle of male ranged from 37-53 days with an average of 45.00 ± 1.2 days, whereas for female, it ranged 38-55 with an average of 46.5 ± 1.8 days (Table 1). Total life cycle of male and female was 38.5 and 39.9 days, respectively^[9].

Mating of adults was usually observed in end to end position, occurring during morning hours. The female raised the wings by exposing its abdomen and the male mounted on the female's back. The mating was observed three times during study and the mating period lasted for 80, 94 and 85 minutes. Mating period was reported to be 3 hours^[13].

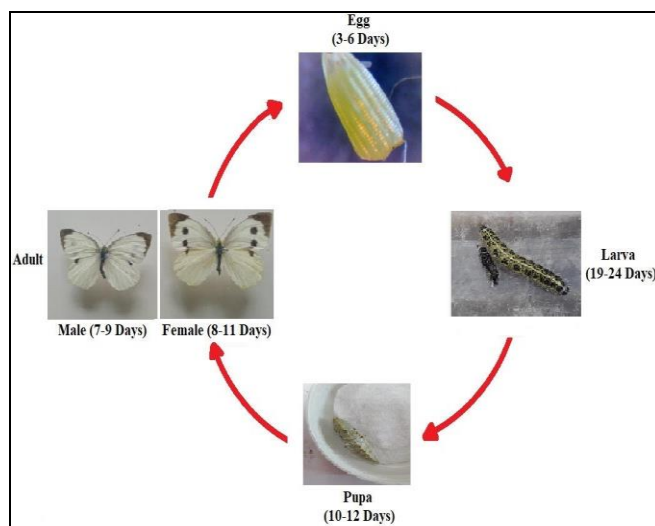


Plate 1: Life cycle of cabbage caterpillar *P. brassicae* (L.)



(a) Parasitized larva

(b) Dead larva

Plate 2 Parasitization of larvae of *P. brassicae*

Nature of damage: Larval stages of *P. brassicae* caused serious damage to the cabbage crop. Newly hatched larvae lacerate the leaf surface of cabbage plants and feed in groups, the grown up ones feed individually and got scattered on

plants. Complete defoliation is occurs in severe infestation, the heads completely fed by larvae and large amount of excreta was found on infected plants.

The Larvae were found to be attacked by *Apanteles* wasp, which laid eggs inside larval body and made cocoons on or adjacent to the larva. The larvae parasitized by *Apanteles sp.* did not show any visible symptoms till formation of cocoon by apanteles or emergence of parasitoid. The Percentage parasitization by *Apanteles* was found to be 8 ± 10.32 . Per cent survival of the larvae ranged from 60-100, with an average survival of 87 ± 12.51 per cent. Total 13% larvae were observed dead, of which 8% larvae died due to parasitization with *Apantele sp.* and remaining 5% mortality occurred due to other unknown factors. Larvae of *P. brassicae* are parsitized by apanteles in natural population^[5]. Larval survival reported to be 83% larval survival of *P. brassicae*^[4].

Table 1: Duration (days) of immature & adult stages of cabbage caterpillar, *P. brassicae* (L.).

Stage	Parameter	Mean \pm S.D	Range
EGGS	Egg duration (days)	4.3 \pm 1.0	3-6
	Hatchability (%)	96.82 \pm 2.93	90-100
	Fecundity(eggs/female)	163.45 \pm 33.67	110-220
Larval Instars (days)	1st instar	4.6 \pm 0.59	3-5
	2nd instar	5.9 \pm 0.44	5-7
	3rd instar	3.5 \pm 0.68	3-5
	4th instar	3.1 \pm 0.30	3-4
	5th instar	4.3 \pm 0.65	3-5
	Larval survival (%)	87 \pm 12.51	60-100
	Total larval duration	21.45 \pm 1.19	19-24
Pupae	duration (days)	10.95 \pm 0.75	10-12
	Survival (%)	95 \pm 7.07	80-100
Adults (days)	Male longevity	8.15 \pm 0.58	7-9
	Female longevity	9 \pm 0.72	8-11
Total Life	Male	45.00 \pm 1.2	37 – 53
	Female	46.5 \pm 1.8	38 – 55

* Data based on 50 observations in each case

Morphometric measurements of different life stages of *P. brassicae*

The larvae of 1st, 2nd, 3rd, 4th and 5th instars measured 6.45 \pm 0.60, 13.3 \pm 0.65, 21.65 \pm 0.48, 33.65 \pm 0.48 and 40.75 \pm 0.63mm in length, respectively, while their breadth values in mm were recorded as 1.0 \pm 0.0, 2.0 \pm 0.0, 2.6 \pm 0.50, 3.75 \pm 0.44 and 4.75 \pm 0.44, respectively (Table 2). The larvae of first, second, third, fourth and fifth instars were measured 6.25, 12.10, 23.65, 32.10 and 40.10 mm in length and 1.10,

2.10, 3.25, 4.25, and 5.35mm in width, respectively^[6]. Similarly, the length of 1st, 2nd, 3rd, 4th, and 5th instar larvae was measured 2.85, 6.4, 13.15, 20.5 and 36.6mm, respectively^[13]. The average length of pupa was measured as 25.65 \pm 0.48mm which ranged from 25-26mm. The breadth of pupae ranged from 6-7mm with an average of 6.55 \pm 0.51mm. The average length and width of pupae was 22.50 \pm 2.63mm and 3.10 \pm 0.1mm respectively^[6].

Table 2: Morphometric measurements of larval and pupal stages of cabbage caterpillar, *P. brassicae* (L.).

Stage		Length(mm)		Breadth(mm)	
		Mean \pm S.D	Range	Mean \pm S.D	Range
Larval Instars	1st instar	6.45 \pm 0.60	5 – 7	1.0 \pm 0.0	1.0 – 1.2
	2nd instar	13.3 \pm 0.65	12 – 14	2.0 \pm 0.0	2.0 – 2.1
	3rd instar	21.65 \pm 0.48	21 – 22	2.6 \pm 0.5	2.0 – 3.0
	4th instar	33.65 \pm 0.48	33 – 34	3.75 \pm 0.5	3.0 – 4.0
	5th instar	40.75 \pm 0.63	40 – 42	4.75 \pm 0.6	4.0 – 5.0
PUPAE		25.65 \pm 0.48	25 – 26	6.55 \pm 0.5	6 – 7

* Data based on 50 observations in each case

Table 3: Body length and breadth of fore and hindwing of adult *P. brassicae*

Stage	Body Length		Forewing		Hindwing	
	Mean \pm S.D	Range	Mean \pm S.D	Range	Mean \pm S.D	Range
Adult (Male)	21.95 \pm 0.60	21-23	30.6 \pm 0.75	30-32	25.6 \pm 0.50	25-26
Adult (Female)	22.8 \pm 0.69	22-24	32.25 \pm 0.71	31-33	26.7 \pm 0.86	25-28

* Data based on 50 observations in each case

The body length of male butterflies ranged from 21 – 23 mm with an average of 21.95 ± 0.60 mm. The breadth of fore wings of male butterflies ranged from 30-32 with an average of 30.6 ± 0.75 mm. The breadth of hind wings of male butterflies ranged from 25-26 mm with an average of 25.6 ± 0.50 mm. The body length of female butterflies ranged from 22-24 mm with an average of 22.8 ± 0.69 mm. The breadth of fore wings of female ranged from 31-33 mm with an average of 32.25 ± 0.7 mm. The breadth of wings of female butterflies ranged 25-28 mm from with an average of 26.7 ± 0.86 mm (Table 3). Female butterflies were larger than male (Plate 1). The wing expanse of male and female butterflies was 5.1 cm and 5.5 cm respectively [6]. Male are smaller than female butterflies [5].

Conclusion

Females were emerged more than males and long lived than males. Females were larger than males and lay eggs on under surface of the leaves. Study on percent parasitization revealed that larvae attacked by apanteles in field condition. Young larvae feed in gregarious manner up to 3rd instar then later on spread over whole plant. To avoid heavy damage done by later instars, we recommend regular survey after successful establishment of seedling to investigate the presence of egg laying and younger larval population for mechanically destruction of eggs and younger larvae found in groups.

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