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## Biology of mustard sawfly, *Athalia lugens proxima* (Klug) on Haliv, *Lepidium sativum*

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**Abstract**

Studies on biology of mustard sawfly on Haliv revealed that the female adult laid 74.60 eggs per female. The incubation period ranged from 6 to 8 days with mean incubation period of  $6.95 \pm 0.69$  days. Hatchability per cent of eggs was 86.67%. The mean larval period and pupal period was observed to be,  $12.65 \pm 1.95$  and  $12.25 \pm 1.37$  days, respectively. The average longevity of male and female mustard sawfly was observed to be,  $13.5 \pm 4.09$  and  $9.75 \pm 3.51$  days, respectively. The average life span of male and female mustard sawfly was observed to be,  $45.35 \pm 6.45$  and  $41.60 \pm 5.69$  days, respectively. Morphometric were recorded as egg (0.44 mm x 0.23 mm), 6<sup>th</sup> instar larva (14 mm x 2.55 mm), pupa (7.70 mm x 4.50 mm), adult male (5.50 mm x 1.70 mm) and adult female (6.60 mm x 2.20 mm).

**Keywords:** Biology, Mustard sawfly, *Athalia lugens proxima*, Haliv, Duration, Period

**Introduction**

Haliv (*Lepidium sativum*) is an erect annual edible medicinal herb belonging to family Brassicaceae. It is known as 'pepper cress' or 'water cress' or 'garden cress'. Its common names include Halim (Sanskrit); Common Cress (English); Chandrashoor (Hindi); Kapila (Kannada) and Haliv (Marathi). It is native to West Asia and Europe (Gokavi *et al.*, 2004) [11]. In India, its cultivation spread across the states of Maharashtra, Gujarat, Uttar Pradesh, Madhya Pradesh and Rajasthan in an area about 5000 hectares (Choudhary *et al.*, 2010) [8]. In India, entire area under garden cress is 8450 ha (Anonymous, 2014) [4]. Plants are 45-60 cm tall. Its leaves are pinnatisect, entire or variously lobbed. Flowers are white and tiny, arranged in racemes. The seeds have laxative and diuretic properties. The seed's mucilage is used to treat intestinal irritations. Leaves are useful for treatment of liver diseases. Salad which made from leaves used to cure anaemia (Anonymous, 2019) [3]. The composition of seed is as moisture (5.69%), protein (23.50%), fat (23.5%), ash (5.7%), sulphur (0.9%), phosphorous (1.65%) and calcium (0.31%) (Wadhwa *et al.*, 2012) [23]. The extract of *L. sativum* possesses antioxidant, anti-diarrheal, anti-microbial, anti-inflammatory and hepatoprotective effects against oxidative damage (Doke and Guha, 2014; Al-Sheddi *et al.*, 2016; Raish *et al.*, 2016) [10,2,16].

*Athalia lugens proxima* (Klug) (Hymenoptera: Tenthredinidae) commonly known as mustard sawfly is a major pest of mustard (Sharma *et al.*, 1992) [19]. Mustard sawfly recorded first time from the Bombay and Bengal State (Middleton, 1894) [14]. Mustard sawfly causes damage to mustard, cauliflower, radish, cabbage and knol-khol. It is reported on garden cress (*Lepidium sativum*) (Anonymous, 2019) [3]. It causes 36.89% seed yield losses in haliv. It is considered as devastating pest of vegetables. This pest generally active during October to March. The host range of this pest includes 14 plant species belonging to Cruciferae and *Tropaeolum majus* (Sehgal and Ujagir, 1977) [18]. The larvae fed on young leaves and then skeletonization of leaves occurred. The larvae also fed on the epidermis of the tender shoots, fruits and flowers (Chowdhury, 2009) [9]. Female causes indirect damage by injuring leaf tissue while inserting the eggs with her ovipositor. The pest attack causes severe defoliation resulting in huge loss in seed yield due to death of plants during early stages and sometimes resowing becomes necessary (Jagtap and Kadam, 1978) [12]. Keeping this in view, research was undertaken entitled with "Biology of mustard sawfly, *Athalia lugens proxima* (Klug) on haliv, *Lepidium sativum*".

**Materials and Methods**

Biological and morphometrics parameters of *A. lugens proxima* were studied at Post Graduate

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The larvae of mustard sawfly were collected from the plot of AICRP on MAP&B, M.P.K.V, Rahuri. Collected larvae were kept in plastic container and it was covered with muslin cloth. Fresh leaves of haliv were provided as food for larvae. To avoid fungal contamination, the food material was replaced daily in the morning hours until the larvae were ready to pupate. For pupation, the fully grown 6<sup>th</sup> instar larvae were shifted to another plastic bowl containing sufficient soil and covered it with the help of muslin cloth. Keep muslin cloth moist by sprinkling water over it. For survival of pupae, sufficient moisture should be maintained inside the plastic bowl.

While examining presence of ovipositor and body size, the adults which emerged from pupae were mated on the same day. In the wooden oviposition chamber, one pair of newly emerged female and male adults was released. Each rearing chamber contained the cotton swab dipped in 5% sugar solution was suspended from the roof of oviposition chamber by using cotton thread and pins to provide food to adults and 30 days old seedlings of haliv provided for oviposition of mustard sawfly. Female laid eggs only on live plants of haliv. Ten pairs of adults are taken in ten different wooden oviposition chambers. The eggs were examined on a daily basis to record the incubation period of eggs, colour of eggs and emergence of neonate larvae. Observations also recorded

on larval period, pupal period and adult longevity. At room temperature, all of the parameters were recorded. Morphometrics observations were taken with the help ocular micrometer and Graph paper and scale method.

## Results and Discussion

The results pertaining to developmental period of different life stages of *Athalia lugens proxima* (Klug) were shown in Table 1 and observations on morphometric were shown in Table 2.

### Egg stage

The female adult of *Athalia lugens proxima* (Klug) laid eggs singly, in slits made with saw like ovipositor along the under sides of the leaf margin. Freshly laid eggs were smooth, creamy white and oval shape which later turned to black. The incubation period was varied between 6-8 days with mean incubation period of  $6.95 \pm 0.69$  days (Table 1). The findings are in line with the observations of Kapadia *et al.* (1980)<sup>[13]</sup> who observed incubation period of 6.21 days under laboratory conditions. In case of size of the eggs, the average length and breadth were measured to be  $0.44 \pm 0.01$  and  $0.23 \pm 0.01$  mm, respectively (Table 2). The present findings are more or less similar to Shirke *et al.* (1968)<sup>[20]</sup> who reported that average length and width of eggs of mustard sawfly on radish were 0.66 and 0.35 mm, respectively.

**Table 1:** Developmental period of different life stages of mustard sawfly, *Athalia lugens proxima* (Klug) on Haliv, *Lepidium sativum*

Sr. No.	Stage	Mean $\pm$ SD (Days)	Range (Days)
1.	Incubation period of eggs	$6.95 \pm 0.69$	6-8
2.	Hatchability (%)	86.67	
3.	Fecundity in numbers	74.60	
4.	<b>Larval period</b>		
	1 <sup>st</sup> instar	$3.25 \pm 0.44$	3-4
	2 <sup>nd</sup> instar	$1.90 \pm 0.64$	1-3
	3 <sup>rd</sup> instar	$1.60 \pm 0.68$	1-3
	4 <sup>th</sup> instar	$2.00 \pm 0.56$	1-3
	5 <sup>th</sup> instar	$2.60 \pm 0.50$	2-3
	6 <sup>th</sup> instar	$1.30 \pm 0.66$	1-3
	Total larval period	$12.65 \pm 1.95$	9-19
5.	Pupal period	$12.25 \pm 1.37$	10-15
6.	Total period taken from egg to adult emergence	$31.85 \pm 3.28$	25-42
7.	<b>Adult longevity</b>		
	Male	$13.5 \pm 4.09$	3-18
	Female	$9.75 \pm 3.51$	2-13
8.	Pre-oviposition period (hours)	$5.15 \pm 1.42$	2-7
9.	Oviposition period (days)	$5.95 \pm 1.47$	2-7
10.	Post oviposition period (days)	$3.80 \pm 2.35$	0-6
11.	<b>Total life span in days</b>		
	Male	$45.35 \pm 6.45$	28-60
	Female	$41.60 \pm 5.69$	27-55
12.	Sex ratio (Male: Female)	1 : 2.33	

### Larval stage

The larva passed through six instars. Larvae had three thoracic pairs of legs with eight pairs of abdominal prolegs. Crochets were absent in prolegs. Larvae on touch suddenly fall to ground and shown feign death behaviour. The number of exuviae formed during every moulting were used to identify larval instars. To study the various larval instars of *Athalia lugens proxima* (Klug) under laboratory conditions, larva that have recently hatched were reared individually in medium sized petri plates by providing food of fresh leaves of haliv. According to Babendreier and Polesny (1999)<sup>[6]</sup>,

mature larva hibernated in the cocoon.

### First instar

The freshly hatched larva was very small. Body was greyish green in colour. Head was black in colour. Body divided into head, thorax and abdomen region. Thorax had three pairs of legs and abdomen had eight pairs of prolegs. The duration of first instar larvae ranged from 3 to 4 days with a mean of  $3.25 \pm 0.44$  days (Table 1). In past, Patil and Pokharkar (1973)<sup>[15]</sup> reported that duration of first instar larva of *Athalia lugens proxima* (Klug) was 2.5 days that reared on radish which is

more or less in line with the present findings. The mean length of first instar larva was  $2.0 \pm 0.01$  mm and average width was  $0.38 \pm 0.01$  mm (Table 4.2). The present work is in conformation with findings of Sumithramma *et al.* (1997)<sup>[22]</sup> (2.03mm x 0.37mm).

**Table 2:** Measurements of different life stages of mustard sawfly, *Athalia lugens proxima* (Klug) on haliv, *Lepidium sativum*

Stage		Average length (mm)	Average width (mm)
Eggs*		$0.44 \pm 0.01$	$0.23 \pm 0.01$
Larva	1 <sup>st</sup> instar	$2.00 \pm 0.01$	$0.38 \pm 0.01$
	2 <sup>nd</sup> instar	$3.40 \pm 0.50$	$0.69 \pm 0.01$
	3 <sup>rd</sup> instar	$5.35 \pm 0.59$	$1.00 \pm 0.01$
	4 <sup>th</sup> instar	$8.15 \pm 1.35$	$1.70 \pm 0.47$
	5 <sup>th</sup> instar	$11.65 \pm 1.53$	$2.20 \pm 0.41$
	6 <sup>th</sup> instar	$14.00 \pm 1.75$	$2.55 \pm 0.51$
Pupa		$7.70 \pm 0.47$	$4.50 \pm 0.51$
Adult	Male	$5.50 \pm 0.53$	$1.70 \pm 0.48$
	Female	$6.60 \pm 0.52$	$2.20 \pm 0.42$
Wing expansion	Male	-	$12.00 \pm 0.82$
	Female	-	$15.20 \pm 0.79$

\* Observations taken at 10 X magnification power

### Second instar

Second instar larva was greyish green with black head. Excreta was green to black colour. This instar was more active than previous instar. The duration ranged from 1 to 3 days with mean duration of second instar larvae ranged from  $1.90 \pm 0.64$  days (Table 1). According to Patil and Pokharkar (1973)<sup>[15]</sup>, the mean duration of second instar larva of *Athalia lugens proxima* (Klug) was 1.80 days which is close to present findings. Second instar had average length of  $3.40 \pm 0.50$  mm and average width of  $0.69 \pm 0.01$  mm (Table 4.2). The current findings are in conformation with findings of Sumithramma *et al.* (1997)<sup>[22]</sup> who reported morphometrics of second instar larva of *Athalia lugens proxima* (Klug) (3.78 mm x 0.71 mm) on mustard.

### Third instar

It was blackish grey with black head. A narrow dark black median line started from mesothorax to tip of abdomen appeared on the dorsal region. Two lateral lines of black spots, one on each side, running from near the head to last segment of abdomen. The duration ranged from 1-3 days. The average period was  $1.60 \pm 0.68$  days (Table 1). Previously, mean period of  $1.85 \pm 0.36$  days on mustard reported by Sumithramma *et al.* (1997)<sup>[22]</sup> which is in support to present investigation. Length of third instar larvae is  $5.35 \pm 0.59$  mm. Its width is  $1.0 \pm 0.01$  mm (Table 2). The current study is in agreement with Sumithramma *et al.* (1997)<sup>[22]</sup> who measured that the mean length and width of third instar larva were 5.20 and 1.02 mm, respectively.

### Fourth instar

The colour of fourth instar was same as third instar. Two rows of black spots and more dark mid dorsal line when compared with third instar. Its duration ranged from 1-3 days. It had mean duration of  $2.0 \pm 0.56$  days (Table 1). According to Sumithramma *et al.* (1997)<sup>[22]</sup>, on mustard the mean duration of fourth instar larva of *Athalia lugens proxima* (Klug) was  $1.85 \pm 0.48$  days which is more or less in support to present investigations. At this stage the larva measured  $8.15 \pm 1.35$  mm in length and  $1.70 \pm 0.47$  mm in width (Table 2). The results are in support to Sumithramma *et al.* (1997)<sup>[22]</sup> who

recorded the length and width of *Athalia lugens proxima* (Klug) were 7.81 and 1.40 mm, respectively when reared on mustard.

### Fifth instar

This instar was voracious feeder on haliv. The head and body were both black in colour. Its duration ranged from 2-3 days with mean period of  $2.60 \pm 0.50$  days (Table 1). Previously, mean duration of  $2.90 \pm 0.44$  days for fifth instar was noticed by Sumithramma *et al.* (1997)<sup>[22]</sup> which is close to present investigation. At this stage the larva measured  $11.65 \pm 1.53$  mm in length and  $2.20 \pm 0.41$  mm in width (Table 2). The present findings are more or less in conformation with findings of Sumithramma *et al.* (1997)<sup>[22]</sup> who reported that average length was 11.62 mm while average width was 2.06 mm for 5<sup>th</sup> instar larvae of *Athalia lugens proxima* (Klug).

### Sixth instar

This instar became sluggish. Both head and body were black coloured. It had duration of 1-3 days with mean duration of  $1.30 \pm 0.66$  days (Table 1). Formerly, mean duration was reported as  $1.55 \pm 0.51$  days by Sumithramma *et al.* (1997)<sup>[22]</sup> which is in accordance to present investigation. At this stage the larva measured  $14.0 \pm 1.75$  mm in length and  $2.55 \pm 0.51$  mm in width (Table 2). Similar observations were noticed by Jagtap and Kadam (1978)<sup>[12]</sup> reported length of six instar larva was 14.24 mm.

### Total larval period

The entire duration of larvae ranged from 9-19 days. The average larval period was  $12.65 \pm 1.95$  days (Table 1). The present findings are more or less in agreement with the findings of Singh and Sachan (1997)<sup>[21]</sup> who found that at the temperature of 20, 25 and 30 °C larvae lasted 13.7, 11.4 and 12.4 days, respectively. On mustard, Bogawat (1967)<sup>[7]</sup> found 12 days larval period.

### Pupal stage

Pupa was exarate type. Pupation took place inside earthen cocoon in the soil. Sixth instar larvae after moulting constructed an earthen cocoon and undergo pupation into it. Body becomes short by contraction. Pupal durations were ranged between 10 to 15 days with mean duration of  $12.25 \pm 1.37$  days (Table 1). According to Kapadia *et al.* (1980)<sup>[13]</sup> and Sahu *et al.* (2018)<sup>[17]</sup>, the duration of pupa of *Athalia lugens proxima* (Klug) was 10-15 days. Kapadia *et al.* (1980)<sup>[13]</sup> reported that mean duration of pupa of *Athalia lugens proxima* (Klug) was 12.79 days. The results of current finding are more or less in line with the above reports. The pupa was  $7.70 \pm 0.47$  mm long and  $4.50 \pm 0.51$  mm broad (Table 2). The present study is in accordance with Sumithramma *et al.* (1997)<sup>[22]</sup> who recorded length of pupae reared on mustard was 7.53 mm.

### Adult stage and adult longevity

Male adult of *Athalia lugens proxima* (Klug) was more active and smaller than female. It had black head. Prothorax was orange in colour and pterothorax was black in colour. Two pairs of wings were smoky with black veins. Abdomen was orange coloured. Male longevity ranged from 3 to 18 days. The average male longevity is  $13.50 \pm 4.09$  days (Table 1). Adult males fed on mustard survived for  $13.20 \pm 3.32$  days, according to Sumithramma *et al.* (1997)<sup>[22]</sup> which is in line with present study. The male adult was  $5.50 \pm 0.53$  mm in

length and its breadth was  $1.70 \pm 0.48$  mm (Table 2). The present study is in accordance with Jagtap and Kadam (1978) [12] measured length of adult male was 5.19 mm and Sumithamma *et al.* (1997) [22] who recorded breadth of adult male was 1.79 mm when reared on mustard. Male had wing expansion of  $12.0 \pm 0.82$  mm (Table 2) which is more or less in line with Kapadia *et al.* (1980) [13] measured wing expansion of male as 10.78 mm.

The colour of adult female and male adult was same. Female was thicker than male and showed presence of saw-like black ovipositor on ventral side at tip of abdomen. Female longevity was ranged from 2 to 13 days with average longevity was  $9.75 \pm 3.51$  days (Table 4.1). The findings are similar to those of Bogawat (1967) [7] who discovered that the mean survival time of adult female was 11 days. The female adult was  $6.60 \pm 0.52$  mm long and  $2.20 \pm 0.42$  mm broad (Table 2). The present study is in accordance with Jagtap and Kadam (1978) [12] investigated length of adult female was 6.61 mm. The breadth of adult female reared on mustard was 2.17 mm recorded by Sumithamma *et al.* (1997) [22]. Female had wing expansion of  $15.20 \pm 0.79$  mm (Table 4.2) which is more or less in line with Kapadia *et al.* (1980) [13] who recorded wing expansion of female as 12.20 mm.

#### Pre-oviposition period

It ranged from 2 to 7 hours with an average of  $5.15 \pm 1.42$  hours (Table 1) which is similar to observations of Sumithamma *et al.* (1997) [22] who recorded average pre-oviposition duration as 5.3 hours on mustard.

#### Oviposition period

The oviposition period of adult female of *Athalia lugens proxima* (Klug) ranged from 2 to 7 days with an average  $5.95 \pm 1.47$  days (Table 1). On mustard, Bogawat (1967) [7] found 6.75 days oviposition duration which is nearly close to present

findings.

#### Post-oviposition period

The post oviposition period of adult female of *Athalia lugens proxima* (Klug) ranged from 0 to 6 days with an average  $3.80 \pm 2.35$  days (Table 1).

#### Fecundity

The fecundity ranged from 23-127 eggs per female with an average of 74.60 eggs laid by a single female. Under controlled conditions, Ahuja and Sehgal (1982) [1] who found that female deposited  $77.70 \pm 5.99$  eggs over her lifetime which is in line with current findings.

#### Hatchability

Hatchability of eggs was 86.67 per cent (Table 1). Similar findings were recorded by Shirke *et al.* (1968) [20] observed the hatchability of eggs ranged from 80.1 to 91 per cent.

#### Sex ratio

It was 1:2.33 (male: female) (Table 1). According to Jagtap and Kadam (1978) [12], a sex ratio of 1:2.6 (male: female) which is close to present study.

#### Egg to adult emergence

Total period required from egg stage to adult emergence was varied from 25-42 days with mean period of  $31.85 \pm 3.28$  days (Table 1). The present investigation was in line with Sumithamma *et al.* (1997) [22] measured time period from egg stage to adult emergence was  $29.10 \pm 1.15$  days.

#### Total life span

The average life span of male and female mustard sawfly was observed to be  $45.35 \pm 6.45$  and  $41.60 \pm 5.69$  days, respectively (Table 1).

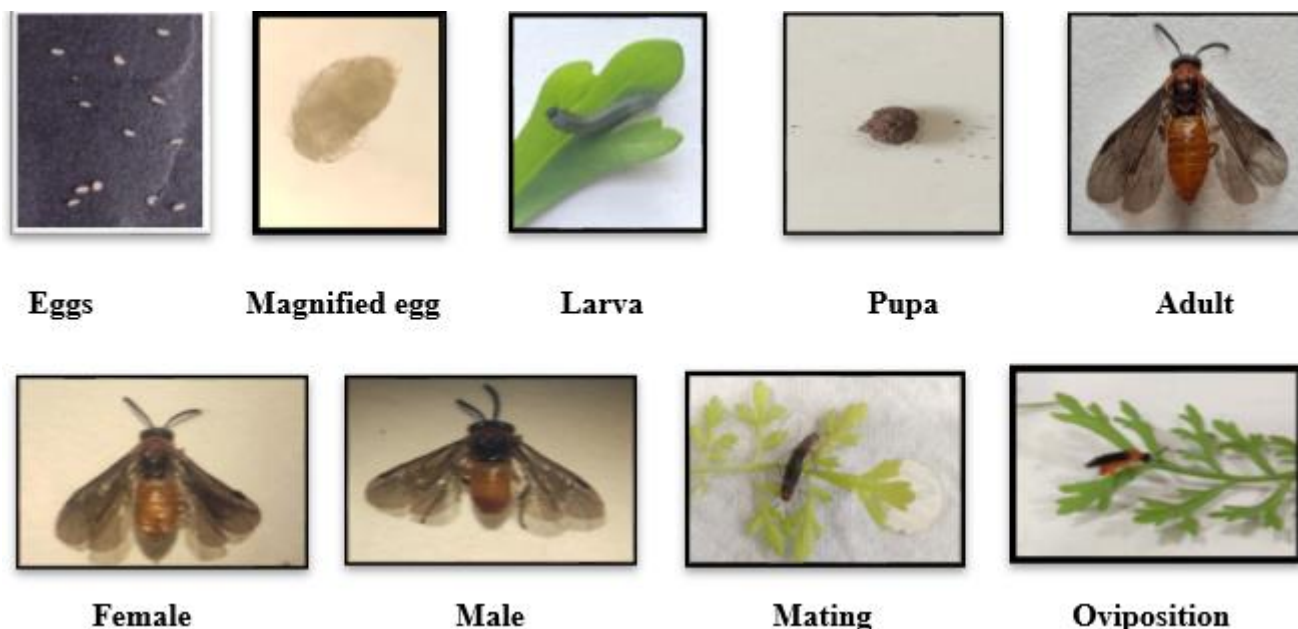


Fig 1: Life stages of mustard sawfly

#### Conclusion

The knowledge of biology of mustard sawfly can be utilized for effective management of this pest. Studies on biology of mustard sawfly on haliv revealed that the female adult laid 74.60 eggs per female. The incubation period ranged from 6

to 8 days with mean incubation period of  $6.95 \pm 0.69$  days. Hatchability per cent of eggs was 86.67%. The mean larval period and pupal period was observed to be,  $12.65 \pm 1.95$  and  $12.25 \pm 1.37$  days, respectively. The average longevity of male and female mustard sawfly was observed to be,  $13.5 \pm$

4.09 and  $9.75 \pm 3.51$  days, respectively. The average life span of male and female mustard sawfly was observed to be,  $45.35 \pm 6.45$  and  $41.60 \pm 5.69$  days, respectively. Morphometric were recorded as egg (0.44 mm x 0.23 mm), 6<sup>th</sup> instar larva (14 mm x 2.55 mm), pupa (7.70 mm x 4.50 mm), adult male (5.50 mm x 1.70 mm) and adult female (6.60 mm x 2.20 mm).

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