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**Research Article**

# Effect of *Aphis craccivora* Koch. reared on different host plants on the biology of *Cheilomenes sexmaculata* (Fabricius)

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**ABSTRACT:** Biology of *Cheilomenes sexmaculata* (Fabricius) was studied on aphids reared on different host plants. The total life cycle of *C. sexmaculata* ranged from 19.56 days to 27.87 days when aphids fed to this were reared on six different host plants *viz*., cowpea, groundnut, cotton, sunflower, greengram and blackgram. Adult male longevity varied from 11.00 to 14.00 days. Adult female longevity varied from 14.00 to 17.00 days. Shortest larval duration (6.75 days) was noticed on cowpea and longest larval duration (8.25 days) was noticed on groundnut. On cotton and sunflower 25 per cent larval mortality each were noticed. The head capsule width of first, second, third and fourth instar larvae of *C. sexmaculata* were 0.28±0.09 mm, 0.42±0.06 mm, 0.58±0.01 mm and 0.63±0.03 mm respectively when fed to aphids from nucleus culture.

**KEY WORDS:** *Aphis craccivora, Cheilomenes sexmaculata,* host plants, larval duration, larval mortality

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## INTRODUCTION

Coccinellids are considered to be of great economic importance and they have been successfully employed in the biological control of many injurious insect pests and are easily available in agricultural ecosystem (Irshad, 2001). The zigzag spotted beetle, *Cheilomenes sexmaculata* (Fab.), commonly known as lady bird beetle is a predaceous coccinellid with wide distribution in South Western Asia, Indonesia, Philippines, South Africa, Pakistan and India. The predatory beetles are efficient feeders and prey on a wide range of soft bodied insects including aphids, plant hoppers, thrips, jassids, scale insects, mealy bugs and white fly infesting large number of cultivated crops (Hussein *et al*., 1986; Rahman *et al.*, 1993; Maisini *et al*., 1994; Solangi *et al*., 2007). Suja and Beevi (2007) studied the efficacy of the potential predators of the pea aphid *A. craccivora* infesting cowpea in laboratory. Among the major predators, the coccinellids, *Coccinella transversalis, Harmonia octomaculata* and *C. sexmaculata* were found to be efficient ones. It is a potential predator of aphids in wide range of agro ecosystem. Here an attempt has been made to study its biology feeding on aphids reared on different host plants.

## MATERIALS AND METHODS

Nucleus cultures of aphids were maintained in a susceptible cowpea cultivar (CO-702). Six different host plants *viz.,* cowpea (var.- GC-3), groundnut (var.- K-6), cotton (var.- Narasimha), sunflower (var.- DRSH-1), greengram (var.- LGG-410) and blackgram (var.- LBG-791) were grown in plastic pots during *Kharif* 2014-15. All the host plants used in the experiment were at peak vegetative stage. Aphids were mass reared on these host plants and used for rearing *C. sexmaculata*.

### Biology of *Cheilomenes sexmaculata*

Stock culture of *C. sexmaculata* beetles were maintained in plastic boxes of 9cm X 14cm. About seven plastic jars containing emerged adults were maintained in the laboratory throughout the experiments. Nymphs and adults of aphids were provided continuously to maintain the populations of coccinellid beetles. The biological parameters of *C. sexmaculata* were studied that were fed on *A. craccivora* reared on different host plants. Individual eggs of lady bird beetle from the stock culture were taken in a small plastic

container of 7cm X 4cm and were provided with aphids reared on six different host plants. Once the eggs hatched, the grubs were provided with third and fourth instar nymphs of aphids reared on six different host plants. All the biological parameters such as duration of egg, instars, pre-pupae, pupae and adult longevity were observed. A total of five replications per host plant (total six hosts) were maintained.

**Morphometrical study of *Cheilomenes sexmaculata***

Morphometrical observations of *C. sexmaculata* were made under binocular stereoscopic microscope when fed on aphids from the nucleus culture (on cowpea var.-CO-702). Data was recorded with respect to body length, body width and head capsule width and were expressed in milimeters (mm).

**RESULT AND DISCUSSION**

Biology of *C. sexmaculata* including larval developmental periods, pupal periods and adult longevity are presented in the Table 1 and 2.

**Egg stage**

**Table 1. Larval developmental periods (in days) of *Cheilomenes sexmaculata* feeding on aphids reared on different host plants**

| Host plants of aphids | Egg | First instar | Second instar | Third instar | Fourth instar | Total larval duration | % Larval mortality |
|---|---|---|---|---|---|---|---|
| Cowpea | 2.25$^{a}$±0.86 | 1.62$^{a}$±0.25 | 1.12$^{a}$±0.25 | 1.37$^{a}$±0.47 | 2.62$^{ab}$±0.62 | 6.75$^{ab}$±1.04 | 00.00$^{a}$±0.00 |
| Groundnut | 2.50$^{a}$±0.70 | 1.75$^{a}$±0.28 | 1.37$^{a}$±0.47 | 2.00$^{ab}$±0.40 | 3.12$^{b}$±0.47 | 8.25$^{c}$±0.28 | 00.00$^{a}$±0.00 |
| Cotton | 2.25$^{a}$±0.64 | 1.75$^{a}$±0.28 | 1.12$^{a}$±0.25 | 1.25$^{a}$±0.70 | 2.37$^{ab}$±0.62 | 6.50$^{a}$±0.70 | 25.00$^{a}$±50.00 |
| Sunflower | 2.50$^{a}$±0.70 | 1.75$^{a}$±0.50 | 1.25$^{a}$±0.28 | 1.37$^{a}$±0.25 | 3.12$^{b}$±0.47 | 7.50$^{abc}$±0.40 | 25.00$^{a}$±50.00 |
| Greengram | 2.37$^{a}$±0.62 | 1.87$^{a}$±0.25 | 1.62$^{a}$±0.47 | 1.87$^{ab}$±0.62 | 2.12$^{a}$±0.25 | 7.50$^{abc}$±0.91 | 00.00$^{a}$±0.00 |
| Blackgram | 2.25$^{a}$±0.64 | 1.87$^{a}$±0.25 | 1.37$^{a}$±0.47 | 2.25$^{b}$±0.86 | 2.37$^{ab}$±0.47 | 7.87$^{bc}$±0.94 | 00.00$^{a}$±0.00 |
| Grand Mean±S.E. | 2.35±0.12 | 1.77±0.06 | 1.31±0.07 | 1.68±0.12 | 2.62±0.12 | 7.39±0.18 | 08.33±28.80 |

Values are mean ± standard deviation, Values followed by same letter are not significantly different at *P*=0.05 level as per DMRT

**Table 2. Pupal periods and adult longevity (in days) of *Cheilomenes sexmaculata* feeding on aphids reared on different host plants**

| Host plants of aphids | Pre-pupal stage | Pupal stage | Adult male longevity | Adult female longevity | Total life span |
|---|---|---|---|---|---|
| Cowpea | 1.00$^{a}$±0.40 | 2.87$^{a}$±0.47 | 14.00$^{d}$±0.70 | 17.00$^{b}$±0.70 | 26.12$^{a}$±1.65 |
| Groundnut | 0.87$^{a}$±0.47 | 2.87$^{a}$±0.25 | 13.00$^{bcd}$±0.70 | 17.75$^{b}$±1.06 | 27.87$^{a}$±1.65 |
| Cotton | 1.08$^{a}$±0.62 | 3.00$^{a}$±0.50 | 11.75$^{ab}$±0.25 | 14.00$^{a}$±0.70 | 19.56$^{a}$±8.86 |
| Sunflower | 0.91$^{a}$±0.52 | 3.16$^{a}$±0.57 | 11.00$^{a}$±0.50 | 14.25$^{a}$±0.35 | 20.68$^{a}$±8.56 |
| Greengram | 0.87$^{a}$±0.47 | 2.75$^{a}$±0.28 | 13.16$^{cd}$±0.47 | 16.33$^{b}$±1.04 | 26.75$^{a}$±1.32 |
| Blackgram | 1.12$^{a}$±0.47 | 2.87$^{a}$±0.25 | 12.16$^{abc}$±0.47 | 16.50$^{b}$±1.00 | 27.37$^{a}$±1.88 |
| Grand Mean±S.E. | 0.97±0.09 | 2.90±0.07 | 12.78±0.89 | 15.89±1.37 | 24.56±1.15 |

Values are mean ± standard deviation, Values followed by same letter are not significantly different at *P*=0.05 level as per DMRT

The adult female lady bird beetle, laid eggs in clusters on both the surfaces of cowpea leaf twigs, inner side of the lids and on the side wall of the plastic jar while maintaining the nucleus culture of lady bird beetles in the laboratory. Freshly laid eggs were cigar shaped, yellow in colour with smooth chorion, but without any reticulations and were laid in vertical position. The eggs turned completely black before hatching. At the time of eclosion, the chorion cracked irregularly and grub wriggled out from the egg. The egg incubation period in the present investigation varied from 2.25 days to 2.50 days and there was no significance difference among the different host plants. The data were in accordance with Selhime (1955), Trehan and Malhotra (1959) and Patel (1989), who reported that the egg incubation period of *C. sexmaculata* ranged between 2.0 and 5.0 days. Suja and Beevi (2007) reported that the egg stage of *C. sexmaculata* was 2.10 days when fed on *A. craccivora.*

**First instar**

Freshly emerged grub was dark grey in colour with shining dark head capsule and legs. The head was broadly rounded anteriorly and jointed with the thorax. The legs were relatively long and articulated with oval shaped body. The duration of first instar larvae ranged from 1.62 days to 1.87 days which were not significantly different.

**Second instar**

Second instar grub was shining black in colour with yellow colour head capsule and black legs. Development of white colour patches was observed on meso and meta thotax and also on fourth and six abdominal segments. The duration ranged from 1.12 days to 1.62 days which were not significant.

**Third instar**

Freshly moulted third instar grub was dull black in colour with yellow head capsule. The colour pattern was more intensified with additional development of white spots on mid dorsal line of other segments except prothorax. Duration of third instar grub was longest when fed with aphids reared on blackram (2.25±0.86 days) followed by groundnut (2.00±0.40 days), greengram (1.87±0.62 days). Shortest duration was observed when grubs were fed with aphids reared on cotton (1.25±0.70 days) followed by sunflower and cowpea (1.37±0.47 days). Duration of third instar grub varied from 1.25 days to 2.25 days, when fed with aphids reared on different host plants (Table 1). Similar larval duration of third instar grubs of *C. sexmaculala* were reported by Veeravel and Baskaran (1996) who mentioned the duration of third larval instar as 2.86, 1.96, 1.50 and 1.60 days respectively at different temperatures like 18°C, 24°C, 30°C and 36°C. According Rai *et al.* (2003) and Tank and Korat (2007), the third instar grub lasted for 1.48±0.11 days and 1.88±0.53 days.

**Fourth instar**

Fourth instar grub was deep black in colour before pupation. It developed additional rectangular dark grey spots in a continuous series mid-dorsally on abdominal segments, whereas spots on the fourth abdominal segments were white. The duration of fourth instar grub was longest when fed with aphids reared on groundnut and sunflower (both 3.12±0.47 days) followed by cowpea (2.62±0.62 days), cotton and blackgram (both 2.37±0.62 days) (not significantly different). The duration of fourth instar grub was shortest when fed with aphids reared on greengram (2.12±0.25 days) (on par with cowpea, cotton and blackgram).

Duration of fourth instar grub varied from 2.12 days to 3.12 days, when fed with aphids reared on different host plants (Table 1). Similar fourth instar larval duration were given by Veeravel and Baskaran (1996) who reported that the duration of fourth instar was 2.60, 1.86, 1.51 and 1.40 days at 18°C, 24°C, 30°C and 36°C respectively. According to Zala (1995) the duration of fourth instar grub was 2.87 days. Suja and Beevi (2007) reported that the duration of fourth instar of *C. sexmaculata* as 3.80 days. Kumar *et al.* (2013) reported duration of fourth instar grub of *C. sexmaculata* to be from three to five days with an average of 4.00±0.58 days.

**Total larval duration**

The total larval duration of lady beetle was longest when fed with aphids reared on groundnut (8.25±0.28 days) followed by blackgram (7.87±0.94 days). The duration was least when fed with aphids reared on cotton (6.50±0.70 days) followed by cowpea (6.75±1.04 days), sunflower (7.50±0.40 days) and greengram (7.50±0.91days).

**Percentage larval mortality**

Highest larval mortality was observed when the grubs were fed with aphids reared on cotton and sunflower (both 25.00±50.00%). No larval mortality was observed in other treatments.

**Pre-pupal stage**

The fully grown grub stopped feeding and became sluggish and swollen before pupation. During this period, the larva attached posterior abdominal segment to the walls of plastic box and pupated in short time. The duration ranged from 0.87 days to 1.12 days, but they were not significantly different.

**Pupal stage**

Fully formed pupa was yellow in colour with black eyes and five pairs of black spots on the dorsal side that were established symmetrically on the segments. The female pupa was distinctly bigger in size than the male ones (Plate 1). When disturbed, only anterior part of the pupa was able to move with its posterior end attached to the substratum. No significant differences were observed in the pupal period (ranged from 2.75 days to 3.16 days), when the insects were fed with aphids reared on different host plants.

**Adults**

The newly emerged adults were soft, yellowish in colour without markings and remained in the pupal cases or outside. Gradually within one to two hours body hardened and turned shining yellow or warm buff with black spots which developed gradually. The elytra were yellow with two wavy markings on each elytra and pronotum was yellow with a median half-moon shaped markings connected with posterior marginal stripe (Plate 1). The morphological observations of the grubs, pupae and adults reported here in

the study were similar to observations made by Zala (1995), Patel (1989) and Tank and Korat (2007).

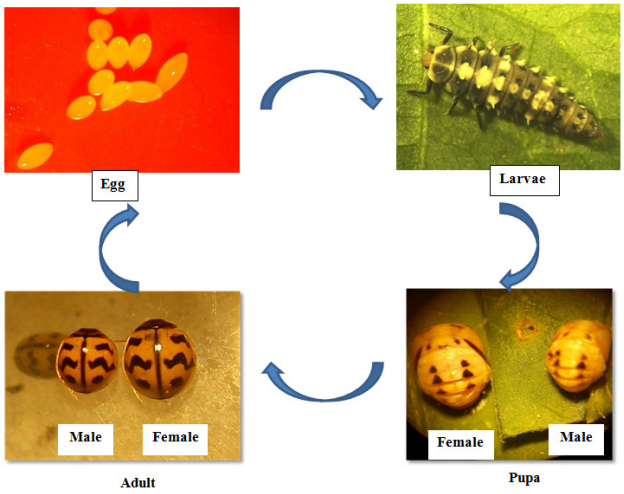


**Plate 1. Life cycle of *Cheilomenes sexmaculata.***

### Adult male longevity

The male beetles were smaller in size, oval and convex dorsally and flat ventrally. They lived for the longer period when fed with aphids reared on cowpea (14.00±0.70 days) followed by greengram (13.16±0.47 days), groundnut (13.00±0.70 days) (both significantly different). The shortest duration of adult male was observed when they were fed with aphids reared on sunflower (11.00±0.50 days) followed by cotton (11.75±0.25 days) and blackgram (12.16±0.47 days).

### Adult female longevity

The female beetles were comparatively bigger in size, oval, convex dorsally and flat ventrally. Female adult beetles lived longer when fed with aphids reared on groundnut (17.75±1.06 days) followed by cowpea (17.00±0.70 days), blackgram (16.50±1.00 days) and greengram (16.33±1.04 days). Shortest life span of female beetles was observed when fed with aphids reared on cotton (14.00±0.70 days) and sunflower (14.25±0.35 days).

### Total life span

The total life span of lady beetles were longest when fed to aphids reared on groundnut (27.87±1.65 days) followed by blackgram (27.37±1.88 days), greengram (26.75±1.32 days) and cowpea (26.12±1.65 days). The shortest duration of female beetles were observed when reared on cotton (19.56±8.86 days) and sunflower (20.68±8.56 days). The average duration of female beetles were 24.56±1.15 days.

Total larval duration of *C. sexmaculata* varied from 6.50 days to 8.25 days, when fed with aphids reared on different host plants (Table 1). Similar larval durations were reported by Tank and Korat (2007) who reported that the larval duration of *C. sexmaculata* ranged between five to ten days. Ali *et al.* (2012) reported that the larval duration was 7.70 days at 28±1°C.

The longevity of male beetle varied from 11.00 to 14. 00 days, when fed with aphids reared on different host plants (Table 2). Our above results were similar to the findings of Gupta (1966) who reported the duration of male beetle longevity as 15.0 days. Zala (1995) reported the adult longevity of male beetles as 16.2 days. Tank and Korat (2007) reported that the same duration ranged from 10 to 21 days with an average of 16.09±2.54 days. According to Lalithambika (2012) the male adult longevity of *C. sexmaculata* was 14.57±0.29 days.

The longevity of female beetle varied from 14.00 days to 17.75 days, when fed with aphids reared on different host plants (Table 2). Eswaramoorthy *et al.,* (1998) conducted a study on the longevity of *C. sexmaculata* and stated that the adults survived for 12.7±3.1 days when fed with aphids *Melanaphis indosacchari* (Zehntner). According to Lalithambika (2012) the female adult longevity of *C. sexmaculata* was 17.71±0.42 days.

The shorter larval duration on cowpea may be due to the early predatory satiation on the same whereas longest larval duration on groundnut may be due to relatively poor nutritional aphids on the later. Percent larval mortality also indicates the low degree of preference of the predator.

### Morphometrical study

The average length and width of egg was 1.11±0.08 mm and 0.49±0.04 mm. The head capsule width of first, second, third and fourth instar larvae were 0.28±0.09 mm, 0.42±0.06 mm, 0.58±0.01 mm and 0.63±0.03 mm respectively. The average body length was increased from 1.38±0.19 mm (in first instar) to 7.03±0.19 mm (in fourth instar). Likewise, body width was increased from 0.45±0.07 mm (in first instar) to 1.44±0.25 mm (in fourth instar). Body length and width of adult male beetle was 4.21±0.11 mm and 3.83±0.55 mm and for the adult female beetle the same was 5.21±0.15 mm and 4.20±0.04 mm respectively (Table 3). The above results were strongly supported by the findings of Zala (1995), Patel (1998) and Tank and Korat (2007).

**Table 3. Morphometrics of *Cheilomenes sexmaculata* (in mm) feeding on nucleus culture of aphids**

| Life stages | Length±S.D. | Width±S.D. | Head capsule±S.D. |
|---|---|---|---|
| Egg | 1.11±0.08 | 0.49±0.04 | - |
| First instar | 1.38±0.19 | 0.45±0.07 | 0.28±0.09 |
| Second instar | 4.22±0.35 | 0.76±0.14 | 0.42±0.06 |
| Third instar | 5.70±0.28 | 0.86±0.02 | 0.58±0.01 |
| Fourth instar | 7.03±0.19 | 1.44±0.25 | 0.63±0.03 |
| Pupae | 3.89±0.70 | 2.52±0.18 | - |
| Adult male | 4.21±0.11 | 3.83±0.55 | - |
| Adult female | 5.21±0.15 | 4.20±0.04 | - |

Data based on 10 individuals.

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