



## Biology and feeding potential of *Coccinella septempunctata* (Linn.) against *Lipaphis erysimi* (Kalt) at different temperature regimes

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**Abstract:** Biology and feeding potential of *Coccinella septempunctata* (Linn.) were studied in laboratory on 3<sup>rd</sup> instar nymphs of mustard aphid (*Lipaphis erysimi* Kalt.) at two different temperature regimes. At 30± 2°C, fecundity, oviposition period, hatchability of eggs, male and female longevity (232±70.46, 12.8±3.91, 82.87±6.66, 22.70 ± 2.21 and 26.60 ± 4.45, respectively) were higher and incubation period, pre-oviposition period, total grub duration and pupal duration (2.6±0.51, 6.5±3.53, 8.7 ± 1.63 and 5.1 ± 1.10, respectively) were lesser in comparison to 25± 2°C where fecundity, oviposition period, hatchability of eggs, male and female longevity, incubation period, pre-oviposition period, total grub duration and pupal duration were 169.8±61.12, 7.9±1.37, 71.68±4.08, 16.2 ± 1.31 and 21.50 ± 1.95, 2.9±0.73, 7.7±2.49, 11.1 ± 1.52 and 5.8 ± 0.918, respectively. At 27± 2 °C, total mustard aphid consumption by a grub of *C. septempunctata* during the whole life span, was 424.4±2.78 mustard aphids in comparison to 272.64±1.79 mustard aphid at 23± 2°C. Similarly an adult male and female consumed 103.2±1.52 and 116.6 ±1.46 aphids per day respectively at 27± 2 °C in comparison to 65.6 ± 1.02 and 71.8 ± 1.60 at 23± 2°C. Thus, at both temperatures aphid consumption increased gradually till 4<sup>th</sup> instar and 30±2°C was found to be most suitable temperature as compared to 25±2°C for the life history of *C. septempunctata*. Hence, it could be concluded that *C. septempunctata* might play a suitable role in bio-intensive Integrated Pest Management programme because of better longevity and high predatory potential against the mustard aphid.

**Keywords:** Biology and feeding potential, *Coccinella septempunctata*, *Lipaphis erysimi*, Rapeseed-mustard

### INTRODUCTION

Rapeseed-mustard, *Brassica juncea* (Linnaeus) is one of the important cruciferous oilseed crops cultivated all over India but its yield is largely affected by number of insect pests. Among all the insect pests, the mustard aphid, *Lipaphis erysimi* (Kaltenbach) (Homoptera: Aphididae) has gained the status of key pest of rapeseed-mustard in India. It feeds by sucking sap from its host and damage to the crop ranging from 9 to 96% in different agroclimatic conditions of India (Singh and Sharma, 2002; Singh and Sachan, 1994; Singh and Sachan, 1995; Parmar *et al.*, 2007). Among all the natural enemies, aphidophagous coccinellids especially *Coccinella septempunctata* is well known potential aphid predator and manage the pest in field (Bilashini and Singh, 2009 Sethi and Atwal, 1964) in mustard ecosystem. Both grub and adults feed voraciously on mustard aphid but their feeding efficiency varies from stage to stage and at different temperatures. For the effective use of predaceous coccinellids in the integrated pest management programme, a complete investigation on their bio-ecology and predation potential are of utmost importance. The knowledge of biology

plays an important role in mass production and its utilization in pest management programme. It is quite evident that temperature has a great impact on biology of this predator. To insight the information on description, duration of different stages of *C. septempunctata* and its feeding propensity on mustard aphid at different temperature, the present study was undertaken in the Laboratory, GBPUA&T, Pantnagar. Being a predator, the knowledge of its biotic potential is helpful in formulating the strategy of biological control of insect pests. Keeping in view the importance of *C. septempunctata* as a biological control agent, the present study was carried out to gather relevant information with particular reference to biology and devouring propensity of this coccinellid at two different temperatures on rapeseed-mustard aphid in the laboratory.

### MATERIALS AND METHODS

#### Maintenance of stock culture of *C. septempunctata*:

The initial culture of *C. septempunctata* was raised by collecting the males and female from the mustard field at Crop Research Center, Pantnagar and reared in the laboratory at 25 ± 1°C and relative humidity 65 ± 5% on mustard aphid in the specimen jars (20×15 cm) dur-

ing the Rabi cropping seasons. Fresh leaves and twigs of mustard harboured with *L. erysimi* were placed inside each jar to provide food to the beetles. The jars were covered with the muslin cloth fastened with rubber bands. The part of the host plants (i.e. leaves/ twigs/ inflorescence etc) with the deposited eggs were kept in separate jars till they become adults.

**Life history of *C. septempunctata* Linn. on *L. erysimi* in laboratory at different temperature regimes:** The biology of *C. septempunctata* was studied in the laboratory at  $30\pm 2^{\circ}\text{C}$  and  $25\pm 2^{\circ}\text{C}$  and RH  $70\pm 5\%$  on *L. erysimi*, on mustard. The males and females were collected from this stock culture and kept separately in petri dishes (15 cm dia) for mating. The mated females individually were allowed to oviposit in separate petridishes (15 cm dia) containing mustard aphid. These petridishes were then kept inside the B.O.D. incubators at two different temperatures viz.  $30\pm 2^{\circ}\text{C}$  and  $25\pm 2^{\circ}\text{C}$  separately to observe incubation period, hatching and successive life history stages of the predator.

The freshly hatched tiny grubs were reared individually in petridishes after providing sufficient food (i.e. first instar nymphs of mustard aphid) to them under 10 replications at two different temperatures viz.  $30\pm 2^{\circ}\text{C}$  and  $25\pm 2^{\circ}\text{C}$ . The duration of different larval instars and pupal period was recorded separately in each replication. After adult emergence, 10 pairs of beetle were released separately in jars ( $15\times 10$  cm) to observe preoviposition, oviposition and post-oviposition periods under ten replications. The number of eggs laid by each female during her life time was also observed. The adult longevity of male and female was also worked out.

**Feeding propensity of grubs and adult of *C. septempunctata* on *L. erysimi*, the mustard aphid:** Total feeding potential of grub and newly emerged adult of *C. septempunctata*, on 3<sup>rd</sup> instar nymphs of mustard aphid (*L. erysimi*, Kalt.) was observed in the laboratory right from the first instar upto 4<sup>th</sup> instar and then newly emerged adult for five consecutive days. The experiments were conducted in  $100\times 17$  mm glass petriplates, at two different temperature regimes viz.  $27\pm 2^{\circ}\text{C}$  and  $23\pm 2^{\circ}\text{C}$  and relative humidity of  $65\pm 5\%$  respectively. Feeding experiments were replicated five times and in each replication single grub/ adult of predator was released. To start with the experiment the grubs and adults were kept starved for 24 hours except the first instar grubs. In each replication, 150 third instar nymphs of mustard aphid were released gently on fresh foliage of mustard with the help of soft camel hair brush (0 number). The experiment was run for 24 hours, thereafter the number of unconsumed aphids left over in petri dishes was counted. The actual number of aphids consumed by grubs/ adult per 24 hrs was calculated.

## RESULTS AND DISCUSSION

**Feeding potential of grubs and adults of *C. septempunctata* on *L. erysimi* in laboratory:** It was evident from the present study (Table 1) that first, second,

third and fourth instar larva of *C. septempunctata* consumed on an average of  $15.86\pm 0.34$ ,  $45.1\pm 0.45$ ,  $124.62\pm 0.88$  and  $238.82\pm 1.11$  aphids respectively at  $27\pm 2^{\circ}\text{C}$  and  $65\pm 5\%$  percent respectively in a total larval period of 9-10 days. During the total larval period the grub consumed on an average of  $424.4\pm 2.78$  mustard aphid and the newly emerged adult male consumed on an average of  $103.2\pm 1.52$  aphids per day as compared to the newly emerged adult female which consumed on an average of  $116.6\pm 1.46$  aphids per day when fed on mustard aphid for 5 consecutive days at similar stress of ecological conditions. However, this result is in contrast to the findings of Gour and Pareek (2003) who reported an average consumption of 612.91 to 613.56 aphids during a complete larval period. Similarly at  $23\pm 2^{\circ}\text{C}$  and  $65\pm 5\%$  percent relative humidity, first, second, third and fourth instar grub of the predator consumed on average of  $19.3\pm 0.29$ ,  $24.38\pm 0.31$ ,  $53.16\pm 0.5$  and  $175.8\pm 0.69$  aphids respectively in a total larval period of 10-11 days ) During the total larval period, the grub consumed on an average of  $272.64\pm 1.79$  mustard aphids. Newly emerged male and female on the other hand consumed  $65.6\pm 1.02$  and  $71.8\pm 1.60$  aphids per day respectively when fed on mustard aphid for 5 consecutive days under similar stress of ecological conditions. Per day aphid consumption by grub during larval period at both the temperatures is evident from Figure 1. This result is in close approximation with Gautam (2002) who observed that the grubs of *C. septempunctata* consumed 281 aphids during its larval period and Singh and Singh (2014) who reported total aphid consumption by grub was 212 aphids. Higher aphid consumption by the female as compared to male *C. septempunctata* has also been reported by Gour and Pareek (2003).

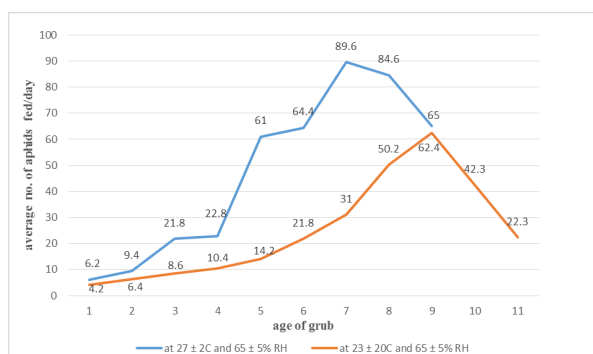
**Life history of *C. septempunctata* on mustard aphid, *L. erysimi* at  $30\pm 2^{\circ}\text{C}$ :** At a temperature of  $30\pm 2^{\circ}\text{C}$  and  $70\pm 5\%$  relative humidity, *C. septempunctata* laid on an average of  $232\pm 5.45$  eggs in its total life span (Table 2). The eggs were cigar-shaped, shining deep yellow in colour and lay in clusters mostly on the under surface of leaves. The incubation period was  $2.6\pm 0.51$  days and an average  $82.87\pm 6.66\%$  hatchability was observed. This finding is in close conformity with Mishra et al. (2005) who observed the incubation period of 3 days with 86.6% hatchability at  $28\pm 2^{\circ}\text{C}$ . The average pre-oviposition, oviposition and post-oviposition period of *C. septempunctata* was  $6.5\pm 3.53$ ,  $12.8\pm 3.91$  and  $3.2\pm 1.31$  days respectively (Table 2). These results are in corroboration with those of Behera et al. (1999), Petro and Behera, (2005), Singh et al. (2009) and Singh and Singh (2014). The average duration of first, second, third and fourth instar larvae was  $1.6\pm 0.69$ ,  $1.7\pm 0.48$ ,  $2.3\pm 0.67$  and  $3.1\pm 0.87$  days respectively. The total larval period ranged from 7-12 days whereas the pupal period varied from 4-7 days. Agarwala and Saha (1986), Behera et al. (1999) reported 12.6 and 9.35 days grub period of *C. septempunctata* on aphids. The longevity of male beetle ranged from 19-26 days while the female adult beetle survived for 21-33 days (Table 2).

**Table 1.** Feeding potential of grubs and adults of *C. septempunctata* on *L. erysimi* at two different temperature regimes.

Instar/adult	23 ± 2 <sup>0</sup> C, 65 ± 5% RH	27 ± 2 <sup>0</sup> C, 65 ± 5% RH
	Average consumption of aphids instar	Total consumption of aphids /instar
1 <sup>st</sup> instar grub	19.3±0.29	15.86±0.34
2 <sup>nd</sup> instar grub	24.38±0.31	45.1±0.45
3 <sup>rd</sup> instar grub	53.16±0.5	124.62±0.88
4 <sup>th</sup> instar grub	175.8±0.69	238.82±1.11
Total no. of aphids consumed during larval development	272.64±1.79	424.4±2.78
Average consumption of aphid/Adult male/day	65.6 ± 1.02	103.2 ± 1.52
Average consumption of aphid/Adult female/day	71.8 ± 1.60	116.6 ± 1.46

**Table 2.** Biological parameters of *C. septempunctata* on mustard aphid, *L. erysimi* at two different temperatures.

Biological parameter	At 30 ± 2 <sup>0</sup> C and 70 ± 5% RH		At 25 ± 2 <sup>0</sup> C and 70 ± 5% RH	
	Mean±SEM	Range	Mean±SEM	Range
Incubation period (in days)	2.6±0.51	2-3	2.9±0.73	2-4
Larval instars (in days)	1.6 ± 0.69	1-3	3.1 ± 0.87	2-4
1 <sup>st</sup> instar	1.7 ± 0.48	1-2	2.2 ± 0.78	1-3
2 <sup>nd</sup> instar	2.3 ± 0.67	1-3	2.1 ± 0.87	1-3
3 <sup>rd</sup> instar	3.1 ± 0.87	2-4	3.3 ± 0.94	2-5
4 <sup>th</sup> instar				
Total grub period (in days)	8.7 ± 1.63	7-12	11.1 ± 1.52	10-13
Pupal period (in days)	5.1 ± 1.10	4-7	5.8 ± 0.918	4-7
Longevity male (in days)	22.70 ± 2.21	19-26	16.2 ± 1.31	14-18
Longevity female (in days)	26.60 ± 4.45	21-33	21.50 ± 1.95	18-24
Fecundity/female (no.)	232±5.45	103-267	169.8±6.78	98-218
% Hatchability	82.87±6.66	73.8 – 94.4	71.68±4.08	65.9-78.32
Pre-oviposition period(in days)	6.5±3.53	3-12	7.7±2.49	4-11
Oviposition period(in days)	12.8±3.91	8-21	7.9±1.37	6-10
Post-oviposition period (in days)	3.2±1.31	2-6	3.9±1.59	2-6



**Fig. 1.** Feeding potential of *C. septempunctata* grub on mustard aphid, *L.erysimi* at two different temperatures.

**Life history of *C. septempunctata* on mustard aphid, *L. erysimi* at 25±2 °C:** Considering the biology of *C. septempunctata* at a temperature of 25±2<sup>0</sup>C and 70±5 % relative humidity it was revealed from Table 2 that the female laid on an average of 169.8±6.78 eggs in its total life span. The incubation period ranged from 2-4 days and average hatchability of 71.68±4.08 % was recorded. The average pre-oviposition period, oviposition period and post oviposition period were 7.7±2.49, 7.9±1.37 and 3.9±1.59 days respectively. The average duration of larval instars was 11.1±1.52 days. Singh and Singh (2014) also

reported average grub duration is 11.15 days on aphid. Average pupal period was 5.8±0.91 days. The adult male and female survived for 14-18 days and 18-24 days respectively. A more or less similar results were obtained by Khurseed *et al.* (2006) who reported that adult male and female beetles survived for 15.24 ±8.10 days and 20.18±.41 days respectively.

These findings are supported by Srivastava (2003) who noticed that the developmental period of this predator was shortest (11.7±0.09 days) at 35<sup>0</sup>C and longest (20.6±0.35 days) at 20<sup>0</sup>C.

### Conclusion

Thus present findings support temperature 30±2<sup>0</sup>C is suitable for *C. septempunctata* development as oviposition period, hatchability of eggs, fecundity and male and female longevity was higher at this temperature. Similarly, it was also revealed that at both temperatures, (23±2<sup>0</sup>C and 27±2<sup>0</sup>C) as the instar/age of grubs increased, the predation rate also increased tangibly and higher feeding propensity of newly emerged female in comparison to male was also evident. Thus it could be concluded that due to high fecundity, longevity and predatory potential, it might play a suitable role in biointensive Integrated Pest Management programmes.

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## REFERENCES

- Agarwala BK, Saha JL (1986). Larval voracity, development and relative abundance of predators of *Aphis gossypii* on cotton in India, pp. 339-344. In: Ecology of Aphidophaga (ed. Hodek, I.), Academia, Prague and Dr. W. Junk, Dordrecht.
- Behera MK, Behera R, Patro B (1999). Biology and feeding potential of *Coccinella septempunctata* Linnaeus (Coleoptera: Coccinellidae) on the chrysanthemum aphid, *Macrosiphoniella sanborni* (Gillette). *J. Biol. Control*, 13:39-43
- Bilashini Y, Singh TK (2009). Studies on population dynamics and feeding potential of *Coccinella septempunctata* Linnaeus in relation to *Lipaphis erysimi* (Kaltenbach) on cabbage. *Indian J. Appl. Entomol*, 23 (2):99-103
- Gautam, R.D.; Subhash, Chander; Sharma, V.K.; Jagdish, Ram and Singh, Ram. (2002). Feeding potential and preference of larval *Coccinella septempunctata* Linn. preying on aphids. *Annals of Agricultural Research*, 23 (1): 1-3
- Gour, I.S. and Pareek, B.L. (2003). Biology and predation potential of *Coccinella septempunctata* Linnaeus on mustard aphid, *Lipaphis erysimi* (Kalt.) in Semi-Arid region of Rajasthan. *Annals of Biology Hissar*, 19 (2): 225-229
- Khursheed, R.; Barkat, Hussain; Ahmad, S.B. and Ashraf, M. (2006). Biology and feeding potential of *Coccinella septempunctata* on mustard aphid, *Lipaphis erysimi*. *International Journal of Zoological Research*, 2(1): 30- 33
- Mishra, S.K.; Kanwat, P.M. and Singh, S.P. (2005). Bionomics of *Coccinella septempunctata* Linn. (Coccinellidae: Coleoptera), a potential predator of mustard aphid. *Annals of Agricultural Research*, 26 (3): 453-457
- Parmar, G.M.; Kapadia, M.N.; Jadav, N.B. and Zizala, V.J. (2007). Avoidable losses due to *Lipaphis erysimi* (Kalt.) in mustard. *Asian journal of Bioscience*, 2 (1/2): 73-75
- Petro D, Behera MK (2005). Biology and feeding potential of some aphidophagous coccinellids (Coleoptera: Coccinellidae) in Orissa. *J. Aphidol*, 19:101-107
- Sethi, S.L. and Atwal, A.S. (1964). Influence of temperature and humidity on the development of different stages of *Coccinella septempunctata* Linn. *Indian J. Agril. Sci.*, 34: 166-171
- Singh YP, Meghwal HP, Singh SP, Sharma KC (2009). Biology and feeding potential of *Coccinella septempunctata* Linnaeus on the mustard aphid, *Lipaphis erysimi* Kaltenbach. *Indian J. Entomol*, 71(30):196-198
- Singh, C.P. and Sachan, G.C. (1994). Assessment of yield losses in yellow sarson due to mustard aphid, *Lipaphis erysimi* kalt. *Journal of Oilseed Research*, 11(2): 179-184
- Singh, C.P. and Sachan, G.C.(1995). Estimation of losses in yield rapeseed. *Brassica campestris* by the mustard aphid, *Lipaphis erysimi*Kalt. In Tarai, India. *Insect science and its application*, 16: 283-286
- Singh, Y.P. and Sharma, K.C. (2002). Integrated approach to manage the mustard aphid *Lipaphis erysimi* (Kaltenbach) (Homoptera :Aphididae) in oilseed Brassica crops- a review. *Journal of Amphibiology*, 16: 77-78
- Srivastava, Shefali. (2003). Influence of temperature on certain biological attributes of a ladybeetle *Coccinella septempunctata* Linnaeus. *Entomologia Sinica*, 10(3): 185-193
- Singh Kuldeep and Singh NN (2014). Biology and devouring propensity of lady bird beetle, *Coccinella septempunctata* Linnaeus on rapeseed mustard aphid, *Lipaphis erysimi* Kaltenbach. *African Journal of Agricultural Research*, 9 (1): 61-64