



## BIOLOGY AND PREDATORY POTENTIAL OF *COCCINELLA SEPTEMPUNCTATA* AND *C. TRANSVERSALIS* FEEDING ON *LIPAPHIS ERSYIMI*

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### ABSTRACT

The biology and predatory potential of *Coccinella septempunctata* and *C. transversalis* feeding on *Lipaphis erysimi* in the mustard ecosystem has been studied. The biology of *C. transversalis* showed that egg, larval, pupal, adult male and female periods were  $2.70 \pm 0.766$ ,  $12.68 \pm 1.633$ ,  $2.62 \pm 0.696$ ,  $30.12 \pm 4.492$  and  $33.88 \pm 2.566$ , respectively while that of *C. septempunctata* were  $4.40 \pm 0.77$ ,  $13.67 \pm 1.77$ ,  $6.73 \pm 1.11$ ,  $31.33 \pm 3.28$  and  $37.30 \pm 3.44$ , respectively. The fecundity and hatching % of *C. transversalis* and *C. septempunctata* were  $364.88 \pm 27.446$ ,  $582.44 \pm 93.15$  egg/female and  $84.73 \pm 8.114$ ,  $73.3 \pm 5.27$  %, respectively. The predatory potential when observed the result reveal that consumption by different instars i.e., 1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup> and 4<sup>th</sup> instar of *C. septempunctata* were  $15.86 \pm 0.34$ ,  $45.1 \pm 0.45$ ,  $124.62 \pm 0.88$  and  $238.82 \pm 1.11$  aphids, respectively, whereas 1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup> and 4<sup>th</sup> instar of *C. transversalis* consumed  $19.95 \pm 3.23$ ,  $34.25 \pm 4.36$ ,  $58.30 \pm 7.54$  and  $65.67 \pm 8.23$  aphids, respectively.

**Key words:** *Coccinella septempunctata*, *C. transversalis*, biology, egg, larval, pupa, adult, periods, predatory potential, *Lipaphis erysimi*

Mustard is grown in all major parts of the country, however, Rajasthan is the leading state in terms of both area and production which is 38.02 and 43.69%, respectively followed by Haryana and Uttar Pradesh (Anonymous, 2019). Study of predating potential and biology of coccinellids will be of great importance for further exploitation of coccinellids in the biological control of mustard aphid which otherwise can cause considerable economic damage. Therefore, keeping all these facts and figures in mind, the present experiment has been oriented to investigate the biology and predatory potential against mustard aphid, *Lipaphis erysimi* by the predatory coccinellids viz. *Coccinella septempunctata* and *C. transversalis*.

### MATERIAL AND METHODS

The experiment was conducted in the Department of Entomology, Banaras Hindu University, during 2020-2021. The experimental materials was collected from BHU agricultural farm like infested mustard twigs and leaves to rear the coccinellids, mustard aphid, *L. erysimi* from infested mustard plants and predator, *C. septempunctata* and *C. transversalis*. The biology of the coccinellids i.e., *C. septempunctata* and *C. transversalis* was studied under laboratory conditions. Newly emerged ten pairs of *C. septempunctata* and *C. transversalis* were sexed, paired and released in to glass

jars with sufficient quantity of mustard aphid as prey maintained separately for their biology studies.

### RESULTS AND DISCUSSION

Preoviposition period of *C. septempunctata* revealed that it lasted from 4 to 13 days, when reared on *L. erysimi*, with an average of  $7.92 \pm 2.45$  days after emergence. During oviposition period the female laid egg and post-oviposition period, the interval from last oviposition to death was found to be varying from 13-26 days with an average of  $21.60 \pm 3.39$  days and 4 to 10 days with an average of  $7.16 \pm 1.77$  days, respectively. Freshly laid eggs in clusters are spindle shaped and yellow in colour, which turns dark before hatching. The fecundity of *C. septempunctata* when reared on mustard aphid *L. erysimi* ranges from 405 to 803 with an average of  $582.44 \pm 3.15$  eggs/ female. The incubation period of *C. septempunctata* varied from 3 to 6 days, with an average of  $4.40 \pm 0.77$  days when reared on mustard aphid *L. erysimi*. After making irregular cracks in chorion grub wriggles out and their hatching percentage were found to be from 66.67 to 80%, with an average of  $73.30 \pm 5.27$ %. The larva of *C. septempunctata* passed through four different instars by moulting in different durations. The biology and duration of *C. septempunctata* grubs are studied at temperature 27°C and RH 75%. The first dark grey instar grub took 3 to 5 days,

with an average of  $3.73 \pm 0.70$  days to transform to next developmental stage. The second instar grub completes its development in 2-4 days, with an average of  $2.80 \pm 0.76$  days. The duration of third instar grub was found to be in the range of 2 to 5 days, with an average of  $3.50 \pm 0.78$ . Through moulting of third instar stage, the grub enters fourth instar developmental stage, which was found to be bigger in body size than the third instar grub. This is the last developmental stage before the grub enters pupation. The fourth instar grub period ranges 2 to 5 days, with an average of  $3.63 \pm 0.85$  days. The total duration taken by all the four instars of grub stage of *C. septempunctata* when reared on mustard aphid, *L. erysimi* varied from 9 to 19 days, with an average of  $13.67 \pm 1.77$  days.

The fourth instar grub stops feeding and became sluggish before pupation. It attaches its abdominal segment at suitable place and become immobile. Pre-pupal shape is curved and within the shed grub skin pupa is formed, which was splitted length wise at the mid-dorsal line from the lateral arms of the epicranial suture to the anterior margin of sixth abdominal tergite. The pre-pupal period of *C. septempunctata* was only of 1 day with an average of  $1.00 \pm 0.00$  days. Freshly emerged pupa is pale yellow in colour which later turns dark with

black and orange markings. The pupal period varied from 5 to 9 with an average of  $6.73 \pm 1.11$  days. The freshly emerged adults are yellow in colour with black colour head and later develop different colorations. The *C. septempunctata* was fed with mustard aphid, *L. erysimi* develops into female and male population shows distinct morphological characters in adult stage after emerging from pupation. In the present study it was observed that male and female sex ratio was 1:1.39. The adult longevity of both the sexes was studied under laboratory conditions and it was observed that female longevity is greater than male longevity i.e., 30 to 45 ( $37.30 \pm 3.44$ ) and 26 to 39 ( $31.33 \pm 3.28$ ) days, respectively (Table 1).

The studies revealed that pre-oviposition period of *C. transversalis* lasted from 4 to 8 days, when reared on mustard aphid, *L. erysimi*, with an average of  $5.22 \pm 0.883$  days after emergence. The oviposition period during which female laid egg and post-oviposition period, the interval from last oviposition to death was found to be varying from 21-28 days, with an average of  $24.08 \pm 1.826$  days and 3 to 6 days, with an average of  $4.58 \pm 0.831$  days, respectively. The incubation period of *C. transversalis* varied from 2 to 5 days, with an average of  $2.70 \pm 0.766$  days when reared on mustard aphid *L.*

Table 1. Biology of *Coccinella septempunctata* and *C. transversalis* on *L. erysimi*

S. No.	Stages/ periods	<i>C. septempunctata</i>			<i>C. transversalis</i>		
		Minimum	Maximum	Mean $\pm$ SD	Minimum	Maximum	Mean $\pm$ SD
1.	Pre- oviposition period	4	13	$7.92 \pm 2.45$	4	8	$5.22 \pm 0.883$
2.	Oviposition period	13	26	$21.60 \pm 3.39$	21	28	$24.08 \pm 1.826$
3.	Post- oviposition period	4	10	$7.16 \pm 1.77$	3	6	$4.58 \pm 0.831$
4.	Fecundity eggs/ female	405	803	$582.44 \pm 93.15$	2	5	$2.70 \pm 0.766$
5.	Incubation period of egg (days)	3	6	$4.40 \pm 0.77$	67.85	97.43	$84.73 \pm 8.114$
6.	Hatching percentage (%)	66.67	80	$873.3 \pm 5.27$	319	423	$364.88 \pm 27.446$
7.	First instar (days)	3	5	$3.73 \pm 0.7$	2	4	$2.60 \pm 0.638$
8.	Second instar (days)	2	4	$2.80 \pm 0.76$	2	4	$2.76 \pm 0.655$
9.	Third instar (days)	2	5	$3.50 \pm 0.78$	2	5	$3.58 \pm 0.831$
10.	Fourth instar (days)	2	5	$3.63 \pm 0.85$	3	5	$3.74 \pm 0.823$
11.	Total larval developmental period (days)	9	19	$13.67 \pm 1.77$	10	17	$12.68 \pm 1.633$
12.	Pre pupal period (days)	1	1	$1.00 \pm 0.000$	1	1	$1.00 \pm 0.000$
13.	Pupal period (days)	5	9	$6.73 \pm 1.11$	2	4	$2.62 \pm 0.696$
14.	Adult longevity (days)						
15.	Male	26	39	$31.33 \pm 3.28$	21	40	$30.12 \pm 4.492$
16.	Female	30	45	$37.30 \pm 3.44$	29	41	$33.88 \pm 2.566$
	Total life cycle (days)						
17.	Male	-	-	-	40	64	$49.12 \pm 4.870$
18.	Female	-	-	-	46	63	$52.88 \pm 3.480$
19.	Adult emergence (%)				57.14	100	$80.36 \pm 10.830$
20.	Sex ratio (male: female)	1.0: 1.22	1.0:1.50	1.0: 1.39			01:01.3

*erysimi*. Their hatching percentage was found to be from 67.85 to 97.43%, with an average of  $84.73 \pm 8.114\%$ . Freshly laid eggs clusters are spindle shaped and yellow in colour, which turns dark before hatching. The fecundity of *C. transversalis* when reared on mustard aphid *L. erysimi* ranges from 319 to 423 with an average of  $364.88 \pm 27.448$  eggs/ female. After moulting, occupying different duration of *C. transversalis* grubs are studied under the laboratory conditions temperature  $27^\circ\text{C}$  and RH 75%. Freshly emerged first instar grubs were found to be dark grey with long legs. The instar grub took 2 to 4 days, with an average of  $2.60 \pm 0.638$  days to complete its morphological development. The second instar grub completes its development in 2-4 days interval, with an average of  $2.76 \pm 0.655$  days. The duration of third instar grub was found to be in the range of 2 to 5 days, with an average of  $3.58 \pm 0.831$ . Through moulting of third instar stage, the grub enters fourth instar developmental stage, which was found to be bigger in body size than the third instar grub. This is the last developmental stage before the grub enters pupation.

The fourth instar grub period ranges 3 to 5 days, with an average of  $3.74 \pm 0.823$  days. The total duration taken by all the four instars of grub stage of *C. transversalis* when reared on mustard aphid, *L. erysimi* varied from 10 to 17 days, with an average of  $12.68 \pm 1.633$  days. The fourth instar grub stops feeding and became sluggish before pupation. It attaches its abdominal segment at suitable place and become immobile. Pre-pupal shape is curved and within the shed grub skin, pupa is formed, which was splitted lengthwise at the mid-dorsal line from the lateral arms of the epicranial suture to the anterior margin of sixth abdominal tergite. The pre-pupal period of *C. transversalis* was only of 1 day with an average of  $1.00 \pm 0.00$  days. Freshly emerged pupa is pale yellow in colour which later turns dark with black and orange markings. The pupal period varied from 2 to 4 days, with an average of  $2.62 \pm 0.696$  days. The freshly emerged adults are yellow in colour with black colour head and later develop different colorations. The *C. transversalis* fed with mustard aphid, *L. erysimi* develops into female and male population shows distinct morphological characters in adult stage after emerging from pupation. In the present study it was observed that there were 43 males on 57 females showing sex ratio of 1:1.30. After completing pupation period *C. transversalis* adults are emerges out. The emergence percentage of adults of *C. transversalis* when reared on mustard aphid, *L. erysimi* was 57.14 to 100 with an average of  $80.36 \pm 10.830\%$ . The total duration of

adult stage of *C. transversalis* is called adult longevity. The adult longevity of both the sexes was studied under laboratory conditions and it was observed that female longevity is greater than male longevity i.e., 29 to 41 ( $33.88 \pm 2.566$ ) and 21 to 40 ( $30.12 \pm 4.492$ ) days, respectively. The total life span of female *C. transversalis* was varied from 46 to 63 with an average of  $52.88 \pm 3.48$  days while in the case of male, it varied from 40 to 64 with an average of  $49.12 \pm 4.87$  days.

The pre-oviposition period of *C. septempunctata* on mustard aphid, *L. erysimi* under laboratory conditions was varied from 4 to 13 with an average  $7.92 \pm 2.45$  days. Varshney et al., (2016) reported pre-oviposition period to be  $6.5 \pm 3.53$  days. The present studies revealed that oviposition of *C. septempunctata* on mustard aphid, *L. erysimi* under laboratory conditions was 13 to 26 days with an average of  $21.6 \pm 3.39$  days and also reported oviposition period of *C. septempunctata* on mustard aphid, *L. erysimi* to be  $12.8 \pm 3.91$  days. In the present studies the post-oviposition period was found to be varied from 4 to 6 with an average of  $7.16 \pm 1.77$  days, which was in agreement with the Yadav et al. (2016). Kumar et al. (2017) reported the post-oviposition period of  $4.33 \pm 0.88$  days of *C. septempunctata* on *L. erysimi*. The total numbers of eggs laid by female adult of *C. septempunctata* ranged from 405 to 803 with an average of  $582.44 \pm 93.15$ , the present findings are in close conformity with the findings of Skouras et al., (2015), who reported that fecundity of *C. septempunctata* was 586 eggs. Mishra and Kanwat (2017) reported that the fecundity of *C. septempunctata* on *L. erysimi* found to be 657.7 eggs, on the other hand Sipio et al. (2017) reported the fecundity to be  $1241.2 \pm 10.25$  eggs.

The incubation period of *C. septempunctata* on mustard aphid, *L. erysimi* varied from 3 to 6 days, with an average of  $4.40 \pm 0.77$  days was similar to the findings of Singh et al. (2009) and Kumar et al. (2019) who reported the incubation period of  $4.40 \pm 0.22$  and  $3.33 \pm 0.33$  days, respectively. The hatching % of *C. septempunctata* was found to be 66.67 to 80 with an average of  $73.3 \pm 5.27\%$  in the present studies, which was in agreement with the Yadav et al. (2017). The period of first instar grub was in range of 3 to 5 with an average of  $3.73 \pm 0.7$  days in the present studies. Rauf et al. (2013) reported the period of first instar grub to be  $3.44 \pm 0.07$  days. The second instar grub period were found to be 2 to 4 with an average of  $2.80 \pm 0.76$  days. Similar results were shown by Rauf et al. (2013) who reported the average duration of second instar grub of *C. septempunctata* on *Schizaphis graminum* which

was found to be  $2.78 \pm 0.10$  days. The third instar grub period of *C. septempunctata* on mustard aphid, *L. erysimi* varied from 2-5 days, with an average of  $3.50 \pm 0.78$  days in present studies which is partially in accordance with the studies of Kumar (2019) who reported the  $3.67 \pm 0.33$  days of average duration of third instar grub period. The developmental period of fourth instar grub of *C. septempunctata* on mustard aphid, *L. erysimi* in present studies ranged from 2 to 5 with an average of  $3.63 \pm 0.85$  days. Sahito et al. (2019) reported the average duration of fourth instar grub as 8.00 days for *C. septempunctata* on mustard aphid, *L. erysimi*. The total developmental period of *C. septempunctata* grub on mustard aphid, *L. erysimi* varied from 9 to 19 days, with an average of  $13.67 \pm 1.77$  days in the present studies. The present findings of pre-pupal period of *C. septempunctata* on mustard aphid, *L. erysimi* were found to be  $1.00 \pm 0.00$  day. Sahito et al., (2019) reported the pupal period of 6.40 days of *C. septempunctata* on mustard aphid, *L. erysimi*. The sex ratio of *C. septempunctata* on mustard aphid, *L. erysimi* were found to be 1.0:1.39.

Mishra and Kanwat (2017) reported the sex ratio of 1.0:1.6 for *C. septempunctata* on mustard aphid, *L. erysimi*. The male longevity of *C. septempunctata* grub on mustard aphid, *L. erysimi* varied from 26 to 29 with an average of  $31.33 \pm 3.28$  days, this present study was found to be in accordance with the findings of Yadav et al. (2016). Kumar et al. (2019) reported the male longevity of  $30.67 \pm 0.67$  days for *C. septempunctata* on mustard aphid, *L. erysimi* and Rauf et al. (2013) reported male longevity of  $44.73 \pm 0.65$  days on *Schizaphis granum*. The female longevity of *C. septempunctata* grub on mustard aphid, *L. erysimi* varied from 30 to 45 with an average of  $37.30 \pm 3.44$  days. Similar results were shown by Kumar et al. (2019) who reported the female longevity of  $36.67 \pm 0.33$  days. The preoviposition period of *C. transversalis* on mustard aphid, *L. erysimi* under laboratory conditions was varied from 4 to 8 with an average  $5.22 \pm 0.883$  days. Bista (2020) reported pre-oviposition period of  $6.40 \pm 0.40$  days when prey was abundant and  $9.20 \pm 0.49$  days when reared under scarcity of prey. The present studies revealed that oviposition of *C. transversalis* on mustard aphid, *L. erysimi* under laboratory conditions was  $24.08 \pm 1.826$  days, which was in close conformity with those of Mari et al. (2016) who recorded the oviposition period of 23.62 days of *C. undecimpunctata* on mustard aphid, *L. erysimi* and 24.22 days on maize aphid. On the other hand, Rajan et al. (2019), Chakraborty and Korat (2014) and Gurung et al. (2018) also reported

oviposition period of *C. transversalis* which were  $13.0 \pm 1.33$ ,  $12.20 \pm 1.27$  and  $9.2 \pm 2.14$  days, respectively. The post-oviposition period was found to be varied from 3 to 6 days with an average of  $4.58 \pm 0.831$  days in present studies, which was in agreement with Mari et al., (2016) who reported the post-oviposition of 4.66 days of *C. undecimpunctata* on maize aphid and Rajan et al. (2019) who reported the postovipsition period of  $4.6 \pm 0.84$  days. The post-oviposition period was also given by Kumar et al., (2019) which was  $5.1 \pm 0.87$  and  $4.33 \pm 0.88$  days, respectively.

The total number of eggs laid by female adult of *C. transversalis* ranged from 319 to 423 with an average of  $364.88 \pm 27.446$  eggs, the present findings are in close conformity with those of Shukla and Jadhav (2014) who reported that the same mean fecundity of *C. transversalis* on mustard aphid, *Lipaphis erysimi* and not in agreement with Junsung (2002) who reported the higher mean fecundity of  $645.27 \pm 213.37$  eggs, while the Chakraborty and Korat (2014) reported the lower fecundity of  $253.85 \pm 38.76$  eggs. The incubation period of *C. transversalis* on mustard aphid, *L. erysimi* varied from 2-5 days, with an average of  $2.70 \pm 0.766$  days under laboratory conditions, this was in close conformity with the findings of Rajan et al. (2019) who reported that incubation period of *C. transversalis* against cabbage aphid *Brevicorne brassicae* was  $2.5 \pm 0.53$  days. It was found that present studies were varied with the findings of Gurung et al. (2018) who reported the incubation period of  $5.2 \pm 1.28$  days of *C. transversalis* on mustard aphid, *L. erysimi*. The hatching percentage of *C. transversalis* was found to be 67.85 to 97.43 with an average of  $84.73 \pm 8.114\%$  in the present studies, while Bista (2020) reported that when the food is scarce the hatching % was  $82.72 \pm 0.67\%$  and with optimum availability of food it goes up to  $89.87 \pm 0.87\%$ . The period of first instar grub was in range of 2 to 4 with an average of  $2.60 \pm 0.638$  days in the present studies. Sarker et al. (2019) reported the first instar grub period of *C. transversalis* were  $2.66 \pm 1.15$  and  $2.66 \pm 0.58$  days on *A. craccivora* and *A. gossypii*, respectively. Mari et al. (2016) reported the period of first instar grub of *C. undecimpunctata* on mustard aphid, *L. erysimi* which was 5.23 days.

Second instar grub period were found to be 2 to 4 with an average of  $2.76 \pm 0.655$  days. Sarker et al. (2019) reported the second instar grub period of *C. transversalis*  $2.66 \pm 0.58$  days on *A. fabae*. The third instar grub period of *C. transversalis* on mustard aphid, *Lipaphis erysimi* varied from 2-5 days, with an



average of  $3.66 \pm 0.831$  days in present studies which is in agreement with Sarker et al. (2019) who reported the third instar grub period of  $3.66 \pm 0.58$  days. Rajan et al. (2019) reported  $3.7 \pm 0.48$  days of third instar grub period of *C. transversalis* on cabbage aphid, *B. brassicae*. The developmental period of fourth instar grub of *C. transversalis* on mustard aphid, *L. erysimi* in present studies ranged from 3 to 5 with an average of  $3.74 \pm 0.823$  days, which was found in partially in accordance with Deho (2009) who reported the period of fourth instar grub of *C. transversalis* on *A. gossypi* which was  $3.9 \pm 0.22$  days. Yadav et al. (2017) reported  $3.63 \pm 0.85$  days of fourth instar grub of *C. septempunctata* on mustard aphid, *Lipaphis erysimi*. The total developmental period of *C. transversalis* grub on mustard aphid, *L. erysimi* varied from 10 to 17 days, with an average of  $12.68 \pm 0.633$  days in the present studies. Similar results were also reported by Shukla and Jadhav (2014) in his studies of biology of *C. transversalis* on mustard aphid, *L. erysimi*. The present findings of pre-pupal period were found to be  $1.00 \pm 0.00$  day, which was in agreement with studies of Rajan et al. (2019) who reported that prepupal period of *C. transversalis* against cabbage aphid *Brevicoryne brassicae* was  $1.2 \pm 0.46$  days. The pre-pupal period was not in agreement with the findings of Gurung et al. (2018), who reported the pre-pupal period of  $4.05 \pm 0.08$  days of *C. transversalis* on mustard aphid, *L. erysimi*. The present finding of pupal period was found to be in range of 2 to 4 days with an average of  $2.62 \pm 0.696$  days, which was in close conformity with the findings of Shukla and Jadhav (2014) who reported the pupal period of  $2.62 \pm 0.69$  days. It was found that present studies were varied with the findings of Chakraborty and Korat (2014) who reported the pupal period of  $8.27 \pm 0.15$  days on bean aphid *A. crassivora*. The sex ratio of *C. transversalis* when reared on mustard aphid, *L. erysimi* was found to be 1:1.32, in the present studies.

The adult emergence in *C. transversalis* on mustard aphid, *L. erysimi* varied from 57.14 to 100 with an average of  $80.36 \pm 10.830\%$ . The male longevity of *C. transversalis* grub on mustard aphid, *L. erysimi* varied from 21 to 40 with an average of  $30.12 \pm 4.492$  days, which is in accordance with the studies of Kumar et al. (2019) who reported the male longevity of  $30.67 \pm 0.67$  days. Similar results were shown by Mari et al. (2016) who reported the male longevity of 30 days of *C. undecimpunctata* on maize aphid. Chakraborty and Korat (2014) reported male longevity of  $21.13 \pm 1.02$  days. The female longevity of *C. transversalis* grub on mustard aphid, *L. erysimi* varied from 29 to 41 days,

with an average of  $33.88 \pm 2.566$  days in the present studies. The total life span of male varied from 40 to 64 with an average of  $49.12 \pm 4.87$  days in the present studies. Junsung et al. (2002) reported the life span of male of *C. transversalis* to be  $37.4 \pm 16.95$  days. The total life span of female varied from 46 to 63 with an average of  $52.88 \pm 3.48$  days in present studies. Junsung et al. (2002) reported the life span of female of *C. transversalis* to be  $45.53 \pm 18.15$  days.

*C. septempunctata* was reared on mustard aphid, *L. erysimi*, the consumption of first instar grub was found to be  $15.86 \pm 0.34$  aphids, which is in contrary with the findings of Sattar et al., (2008) who reported that the first instar grub of *C. septempunctata* consumed 21.9 cotton aphids. Singh et al. (2009) reported that the consumption of first instar grub was found to be 19.72 aphids. The second instar grub on an average consumed  $45.1 \pm 0.45$  aphids, as also reported by Jandilal and Malik (2006) who computed the consumption of second instar grub as 40 aphids. The present studies are not in agreement with the findings of Sattar et al. (2008) who computed the mean consumption of second instar grub of 55.9 days. The average of predatory potential of 3<sup>rd</sup> instar grub was found to be  $124.62 \pm 0.88$  aphids in the present studies, which is in partial accordance with the studies of Sattar et al. (2008) who reported the average consumption of 107.4 aphids by the third instar grub. During the course of this present study the 4th instar grub showed an enhanced predation up to  $238.82 \pm 1.1$  aphids. Pareek et al. (2014) observed similar results of  $237.37 \pm 88.37$  aphids as average consumption by fourth instar grub of *C. septempunctata* when reared on coriander aphid, *Hyadaphis corriandri*. The total number of aphids consumed during larval period was found to be  $424.4 \pm 2.78$  aphids which is in agreement with the findings of Varshney et al., (2016) who reported total number of aphids consumed during larval period was  $424.4 \pm 2.78$  aphids at  $27 \pm 2^\circ\text{C}$ , which was recorded to be  $272.64 \pm 1.19$  aphids (Table 2).

*C. transversalis* was reared on mustard aphid, *L. erysimi*, the consumption of first instar grub was found to be  $19.95 \pm 3.23$  aphids, which is in close conformity with the findings of Gurung et al. (2018) who reported the average consumption of first instar grub of *C. septempunctata* to be  $15.4 \pm 4.39$  aphids. In the contrary of present studies Bukero et al., (2015) reported that 4.0 aphids were consumed by first instar grub of *C. transversalis* was reared on mustard aphid, *L. erysimi*. The second instar grub on an average consumed

Table 2. Predatory potential of *C. septempunctata* and *C. transversalis* on *L. erysimi*

S. No.	Deferent stages	<i>C. septempunctata</i>	<i>C. transversalis</i>
		Total consumption of aphid / instar	
1.	First instar	15.86± 0.34	19.95± 3.23
2.	Second instar	45.1± 0.45	34.25± 4.36
3.	Third instar	124.62± 0.88	58.30± 7.54
4.	Fourth instar	238.82± 1.11	65.67± 8.23
5.	Total no. of aphids consumed during larval development	424.4± 2.78	58.32± 5.23
6.	Average consumption of aphid/ adult male/ day	103.2 ± 1.52	62.17± 5.76
7.	Average consumption of aphid/ adult female/ day	116.6 ± 1.46	49.77± 5.24

34.25± 4.36 aphids, as also reported by Borah and Dutta (2010) in their studies of *C. transversalis* reared on mustard aphid, *L. erysimi*. Bukero et al. (2015) reported the predatory potential of second instar grub to be 9.34 aphids which is not in agreement with the present studies. The average of predatory potential of 3<sup>rd</sup> instar grub was found to be 58.30± 7.54 aphids in the present studies, which was in accordance with the studies of Bukero et al. (2015) who reported the average consumption of third instar grub to be 53.61 aphids, when *C. transversalis* was reared on *A. gossypii*. During the course of this present study the 4th instar grub showed the average consumption of 65.67± 8.23 aphids. Borah and Dutta (2010) observed the same results as the present findings, while in contrary Bukero et al. (2015) reported the average consumption of 4th instar grub to be 31.96 aphids. The average consumption by adult female and male was found to be 58.32± 5.23 and 62.17± 5.76 aphids/ day/ individual, respectively. The present studies were found to be in partial agreement with the findings of Bukero et al. (2015) who reported the average consumption by adult female and male as 44.99 and 56.56 aphids/day/individual, respectively and in contrary he also reported the average consumption by adult female and male as 121.04 and 145.08 aphids/ day/ individual, respectively when reared on *A. gossypii*. The present studies revealed that the predatory potential found to be increased with increase in grubs age i.e., highest aphids were consumed by fourth instar grub of *C. transversalis* and *C. septempunctata* which were 65.67± 8.23 and 238.82± 1.11, respectively (Table 2). The overall consumption was found to be maximum for females which shows that female devour a greater number of aphids than males (Rajan et al. (2019)).

Coccinellid beetles are important predators against a number of sucking pests in Agri-horticultural crops. The ladybird beetles, *C. septempunctata* and *C. transversalis* observed to complete their metamorphosis through four developmental stages viz., egg, grub, pupa and adult.

Except egg and pupal stage, all the developmental stages of the predator were observed to attack the pest and consumed it having differential preference. It is concluded that both the *C. septempunctata* and *C. transversalis* have certain attributes such as high fecundity, amenability of laboratory rearing makes them an ideal candidate for the control of aphid, (*L. erysimi*). As the predatory potential of *C. septempunctata* was found to be greater with that of *C. transversalis*. For effective control of mustard aphid, *L. erysimi*, *C. septempunctata* were found to be the effective tool, so as to keep the pest population below economic injury level, it should be utilized in the integrated pest management strategies.

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#### AUTHOR CONTRIBUTION STATEMENT

Jaya Paliwal-she is M.Sc (Ag) student her thesis and myself her supervisor.

#### CONFLICT OF INTEREST

There are no conflict of interest.

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