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BIOLOGY AND PREDATORY POTENTIAL OF *COCCINELLA SEPTEMPUNCTATA* LINN. ON *LIPAPHIS ERYSIMI* KALT. UNDER CONTROLLED CONDITIONS

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Abstract

The first, second, third and fourth instar nymphal periods were completed in 1 to 3 days. The total nymphal period varied from 8.19 to 9.45 days. The pre-reproductive, reproductive and post-reproductive periods were 1.25 to 1.53, 14.33 to 17.20 and 2.40 to 2.64 days, respectively. The adult longevity was 13.53 to 16.77 days. The daily fecundity varied from 4.93 - 6.05 nymphs per female per day. The eggs of *C. septempunctata* hatched in 3 days with 86.66 percent hatchability. Pre-oviposition, oviposition and post-oviposition periods were found 6.7, 13.4 and 3.3 days, respectively. Female laid about 657.7 eggs during its life span. The grubs passed through four instars were in 9.27 days. Average pupal period was 6.52 days. The average longevity of the male was 21.08 days while that of the female was 25.50 days. Feeding efficiency of *C. Septempunctata* revealed that individual grub required 610.25 aphids for completion of larval development. Female beetle devoured more aphids (153.64) as compared to males (121.55). The first, second and third instar maggot of *X. scutullarae* consumed 26.74, 173.89 and 251.08 aphids, respectively during its larval development.

Key words : Biology, *Coccinella septempunctata*, *Xanthogramma scutullarae*, *Lipaphis erysimi*, preying efficiency.

Introduction

Mustard, *Brussica juncea (L.)* Czern and Coss is important oilseed crops of Cruciferae family and occupy prominent place among oilseed crops being next to groundnut in importance. The average productivity of rapeseed and mustard crops is quite low in India due to a number of abiotic and biotic stresses, e.g. non-adoption of improved technology and cultivation in rainfed and marginal lands having low fertility. In addition, the insect-pests and diseases also cause heavy damage to the yield potential of these crops (Singh, 1986 and Bakhetia and Sekhon, 1989). The mustard crop is damaged at various stages of plant growth by a number of insect pests *viz;* mustard sawfly *(A thalia lugens proxima* Klug.), painted bug *(Bagrada cruciferarum* Kirk.), mustard aphid *(Lipaphis erysimi* Kalt.), cabbage leaf webber *(Crocidolomia binotalis* Zeller), flea beetle *(Phyllotreta cruciferae* Geoze) and leaf miner *(Phytomyza horticola* Meign). Among these, mustard aphid *(Lipaphis erysimi* Kalt.) is of prime significance, which tolls upto 91.30 per cent seed yield (Singh and Sachan, 1994). This pest alone can devastate the entire mustard crop. Both nymph and adult cause damage by sucking the cell sap from leaves, petioles, tender stems, inflorescence and pods. Due to continuous desaping by large aphid population, yellowing, curling and subsequent drying of leaves takes place, which ultimately leads to formation of weak pods and undersized grains. The aphids also secrete the honey dew which provides suitable medium for the development of sooty mould which ultimately hampers the process of photosynthesis. On the basis of economic importance, mustard aphid is considered to be a key pest (Bakhetia and Sekhon, 1984). Indiscriminate and repeated use of pesticides has resulted in plethora of problems, e.g., resurgence of minor insect-pest, insecticidal resistance in insects, mortality of natural enemies and insecticidal resistance leading to various health hazards, and the increased cost of cultivation per unit area (Singh, *et al.,* 1986). To overcome these problems, it has now become imperative to minimise the use of insecticides for

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controlling the pest by way of adoption of other methods like cultural and biological tactics in a compatible manner, so as to keep the pest population below economic injury level. Utilization of biocontrol agents like predators and parasitoids has great potential to keep the population of various pests (Sunil *et al*., 2007). The bio-control agents like Coccinellids, chrysopids and syrphids have been reported to be effective for controlling the aphid, *Lipaphis erysinri* (Kalt.) Shukla *el al.* 1990). The ladybird beetle, *Coccinella septempunctata* Linn. (Coccinellidae: Coleoptera) is well known and diverse group of predator beetle feeding on soft bodied insect pests. It is found in many habitats, including fields, gardens, forests, sea coast, mountains and cities (Ali and Rizvi, 2009). Seven-spotted ladybird beetles are predaceous on various types of aphids (rose aphid, green peach aphid, green bug aphid and green mustard aphid), mealy bugs, sugarcane aleyrodid, citrus psyllid, mites and sorghum stem borer, *Chilo partellus*. The predator has high potential of predation both in the immature as well as adult stage (Shepard, 1998). Therefore, present studies were conducted to investigate the biological parameters and predatory potential of *C. septempunctata* and *Xanthogramma scutullarae* feeding on *Lipaphis erysimi* under controlled condition.

Materials and Methods

The experiment was carried out in the laboratory of the Department of Entomology, S.K.N. College of Agriculture, Jobner. To start with, a few beetles (males and females) were collected from mustard fields. The beetles were confined to glass jars (size 15 cm × 10 cm) at 28±2°C in a biological oxygen demand (B.O.D.) incubator to obtain eggs. Fresh leaves and twigs of mustard harbouring aphids were kept in each glass jars to serve as food for beetles. The glass jars were covered with the muslin cloth fastened with rubber bands. The eggs laid by the female on the surface of glass jars were removed with the help of a moist camel hair brush, whereas, those deposited on the leaf surface or twigs were removed along with the piece of leaf or twigs. Care was taken that the eggs were not damaged. The eggs obtained in this way were used for the incubation studies.

The eggs were placed in petridishes (size 5 cm diameter) whose bottoms were covered with circular blotting papers. The petridishes containing eggs were placed at constant temperature of 28±2°C in a B.O.D. incubator. Observations on hatching of eggs were taken twice a day. The freshly emerged grubs (less than twelve hours old) were reared individually in petridishes. Whole experiment was replicated 10 times. The grub period, instars (presence of exuviae), pre-pupal and pupal period were recorded separately. The aphids collected from unprotected mustard fields were provided as food to grubs and adults after every 12 hours intervals. In general the males were smaller than the females and may be differentiated by the presence of fringe of hairs on the ventral side of the last abdominal segment. In the females, this segment had many punctures. Besides this the last abdominal segment was trunkate in case of males but rounded in females. The above confirmations were carried out under the binocular microscope. Newly emerged adults were released in pairs (1 male and 1 female) in glass specimen tubes (15 × 10 cm) and observations on pre-oviposition, oviposition and post- oviposition periods were recorded separately. The number of eggs laid by each female during her life span was also observed. The adult longevity of male and female was also determined. The male and female ratio was determined based upon 170 adults, collected from mustard fields.

Observations on the rate of feeding of aphids by various immature and mature stages of lady bird beetle, C. *septempunctata* and syrphid fly*, X scutellarae* were recorded in a B.O.D. incubator under laboratory conditions at 28±2°C. Petriplates (size 5 cm diameter) were used for these studies. Known number of aphids (nymphs + adults) along with fresh leaves/inflorescence of mustard were given to each predator after every 12 hours. The aphids which remained alive (not preyed by predators) were counted at every 12 hours to find out the actual number of aphids consumed by the various stages of the predator. The average number of aphids consumed by the predator was calculated.

Results and Discussion

Duration of various stages of *Coccinella septempunctata*

The perusal of data presented in table 1 revealed that the incubation period of eggs was 3 days. The average hatchability was 86.66 per cent ranging from 71.69 to 100 per cent. Hassan *et a*l. (1999) reported that eggs of *C. septempunctata* incubated in 3.6 and 3.5 days at 20°C and 25°C, respectively with and 82% egg hatchability at 25°C. These results differed from Sarwar and Saqib (2010) who found 59.5% egg hatchability at 25°C feeding on natural diet The data presented in table 2 indicated that the pre-oviposition period of the females varied from 3 to 12 days with an average of 6.7 days. The oviposition period varied from 6 to 23 days with an average of 13.4 days, while the post-oviposition period was of 2 to 6 days with an average of 3.3 days. A female laid an average of 657.7 eggs with a range of 143 to 1063 eggs in her total oviposition period. Present findings are in agreement with

Table 1 : Incubation period and percent hatchability of the eggs of *C. septempunctata* at 28±1^{0}C.

No. of eggs observed	Incubation period	No. of eggs hatched	Hatchability of egg (%)
20	3	17	85.00
38	3	35	92.10
49	3	43	87.75
56	3	41	73.21
65	3	54	83.07
70	3	66	94.28
75	3	66	88.00
79	3	79	100.00
95	3	87	91.57
106	3	76	71.69
Average	-	56.4	86.66
Range	-	17.87	71.69 – 100
SEM ±	-	6.65	2.66

Table 2 : Pre-oviposition, oviposition and post- oviposition period and fecundity of *C. septempunctata* female at 28±1^{0}C.

Period (days)			Fecundity/female
Pre - oviposition	Oviposition	Post - oviposition	Number of eggs
4	15	4	671
3	9	3	524
4	17	3	878
10	6	2	143
7	10	2	561
12	18	4	893
9	10	2	548
6	15	3	689
5	23	4	1063
7	11	6	607
Average : 6.7	13.4	3.3	657.7
Range : 3.12	6 – 23	2 – 6	143 – 1063
SEM ± : 0.86	1.52	0.37	74.86

Table 3 : Duration of various instar of the grub *C. septempunctata* at 28±1^{0}C.

Instar	Individual observed	Average duration	Range (day)
First	15	1.66 ± 0.40	1-2
Second	15	1.73 ± 0.44	1-2
Third	15	2,53 ± 0.49	2-3
Fourth	15	3.26 ± 0.37	3-4
Total grub duration (days)	**-**	**9.27 ± 0.32**	**7-11**

Note : Each grub passed through pre-pupal stage of 6-12 hours before transforming in to pupa

Table 4 : Pupal period, adult longevity and sex-ratio of *C. septempunctata* at 28±1^{0}C.

Stage	Individuals observed	Average duration (days) ± SE	Range (days)
Pupa	15	6.52 ± 0.39	5 – 7
Adult			
(a) Male	25	21.08 ± **1.23**	19 - 26
(b) Female	25	25.50 ± **1.69**	21 - 32

Sex ratio = $\frac{\text{Total insect observed}}{170}$ $\frac{\text{Male}}{63}$ $\frac{\text{Female}}{107}$

Sex ratio (Male : Female) = 1 : 1.6

those of Malhotra (1972) and Singh and Malhotra (1979).

The data presented in table 3 indicated that the grub passed through four instars to become a pupa. The average duration of first, second, third and fourth stage grub was 1.66±0.40 (1-2 days), 1.73±0.44 (1-2 days). 2.53±0.49 (2-3 days) and 3.26±0.37 (3-4 days), respectively. The average duration of all the four instars of a grub was 9.27±0.32 with a range of 7-11 days. Each grub passed through the pre-pupal stage of 6-12 hour before transforming into pupa. Sattar *et al*. (2008) observed that total larval and pupal duration of *C. septempunctata* was 18.3 and 4.9 days at 26±1°C when feeding on cotton aphid. The difference in developmental period of predator may be due to nature and quality of prey. The average pupal period was 6.52±0.39 days ranging from 5 to 7 days. On an average the male adult survived for 21.08±1.23 days with a range of 19-26 days, while the female adult survived for 25.50±1.69 days with a range of 21-32 days. The sex ration of male and female was 1:1.6 (Male : Female) (table-4) Present findings get partial support from the findings of Malhotra (1972) and Singh and Malhotra (1979) who observed the sex ratio of 1: 1.8 (Male : Female).

Predatory potentiality of predators on mustard aphid, *L. erysimi* at 28±2°C

Five predators, *viz; Coccinella septempunctata, Menochilus, sexmaculatus, Coccinella transversalis, Adonia variegata* and *Xanthogramma, Scutellarae* were recorded on mustard crop predating upon the aphid, *Lipaphis erysimi* during both the years of study. Out of these, C. *septempuizctata* and *X.scutellarae were* found as a dominant predators.

Coccinella septempunctata

The data presented in table 5 revealed that there were four instars of *C. septempunctata* grubs which lasted for 2, 2, 3 and 4 days, respectively. The present findings are in accordance with those of Singh *et al.*

Table 5: Predatory potentiality of lady bird beetle, *C. septempunctata* (grub) on mustard aphid, *L. Erysimi* at 28±1^{0}C.

Stage and age (day)	No.of grubs examined	Total No. of aphid consumed	Average number of aphid consumed/day/individual	Remarks
1st instar (grub)				
1st	12	121	10.08	-
2nd	12	167	13.91	-
Total aphid consumed by 1st stage grub	-		23.99	-
2nd instar (grub)				
1st	12	358	29.83	-
2nd	12	469	39.08	-
Total aphid consumed by 2nd stage grub	-	-	68.91	-
3rd instar (grub)				
1st	12	643	53.58	-
2nd	12	726	60.50	-
3rd	8	503	62.87	4 turned in to next stage
Total aphid consumed by 3rd stage grub	-	-	176.95	
4th instar(grub)				
1st	12	879	73.25	-
2nd	12	1029	85.75	-
3rd	7	648	92.57	5 pupated
4th	4	359	89.75	8 pupated
Total aphid consumed by 4th stage grub	-	-	341.32	-
Total aphid consumed during grub stage			611.17	

Table 6 : Predatory potentiality of lady bird beetle, *C. septempunctata* (adult) on mustard aphid, *L. erysimi* at 28 ± 2^{0}C

Female		Male	
Average number of aphids consumed/day/ individual± SE	Total life (days)	Average number of aphids consumed/day/ individual± SE	Total life (days)
155.33 ± 5.35	26	113.16 ± 8.47	21
145.66 ± 5.35	22	130.16 ± 5.74	25
157.83 ± 12.08	26	118.50 ± 8.68	23
146.16 ± 1.93	21	127.83 ± 6.39	25
154.00 ± 6.44	23	132.66 ± 7.44	26
163.66 ± 10.83	24	109.33 ± 7.17	19
153.50 ± 6.15	24	125.88 ± 11.93	22
148.83 ± 12.12	22	129.33 ± 12.19	24
164.66 ± 5.16	25	132.66 ± 11.09	25
162.50 ± 4.67	28	126.00 ± 7.94	26
171.66 ± 4.20	29	127.50 ± 8.59	24
176.16 ± 9.36	31	135.27 ± 8.93	26
Total : 1899.95		**1508.28**	
Range : 145.66 – 176.16	21 – 31	109.33 – 135.27	19 – 26
Average/adult/day: 158.32 ± 1.03	25.08 ± 1.94	125.69 ± 3.26	23.83 ± 1.63

(1994) and Gour (2001) who reported four instars of grub of *C. septempunctata*. Singh and Singh (1994) reported total duration of larval instars of *C. septempunctata* 11 days, whereas, Singh *et al.* (1994) found larval period ranging from 10-16 days average of 13 days corroborate the present findings. It was observed that first, second, third and fourth instar grubs consumed 23.99, 68.91, 176.95 and 341.32 aphids (nymphs + adults) in the total grub life span of 11 days. Tangible as the instar/age of the grubs increased, the predation rate also increased, the rate of feeding among different larval instars varied greatly. The duration of each larval instar was also responsible for rate of feeding. An individual in order to complete its larval development on an average consumed 611.17 aphids. The gradual increase in the feeding rate of older larvae explained their increased requirement of food due to their increase in size. An adult predator desirous to feed upon approached an aphid and bent its head to catch it. Once the prey was held between the mandibles, its body fluid was eaten and the skin was thrown out. In case of small aphids the predator took the sap partially and swallowed its completely. The present findings are in conformity with that of Gour (2001) who reported that grubs of *C.*

Table 7: Predatory potentiality of syrphid, *Xanthogramma scutellarae* (maggot) on mustard aphid, *L. erysimi* at 28 ± 2^{0}C

Stage and age (day)	No.of aggot examined	Total No. of aphid consumed	Average number of aphid consumed/day/individual	Remarks
1st instar (maggot)				
1st	12	29	2.41	-
2nd	12	86	7.16	-
3rd	12	219	18.25	
Total aphid consumed by 1st stage maggot	-	-	27.82	-
2nd instar (magotg)				
1st	12	403	33.58	-
2nd	12	748	62.33	-
3rd	10	783	78.30	2 turned in to next stage
Total aphid consumed by 2nd stage maggot	-	-	174.21	-
3rd instar (maggot)				
1st	12	831	69.25	-
2nd	12	769	64.08	-
3rd	6	367	61.16	6 pupated
4th	3	176	58.66	9 pupated
Total aphid consumed by 3rd stage maggot	-	-	253.15	
Total aphid consumed during maggot stage			455.18	

septempunctata consumed 22.86 – 24.53, 71.13 – 71.67, 178.66 – 185.48 and 333.44 – 338.70 aphids (nymphs + adults) during 1st to 4th instars, respectively. Contrary to the present finding, Singh *et al.* (1994) reported that the grub of C. *septempunctata* consumed 100.00, 92.50, 171.50 and 503.50 aphids during first to fourth instars. Perusal of data of table 6 revealed that, the rate of predation of aphids by the male coccinellid varied from 109.33 to 135.27 aphids per day with an average of 125.69 during the life span ranging from 19 - 26 days (avg. 23.83 days). The female beetles survived for 21-31 days (av. 25.08 days) During this period, a female beetle consumed 145.66 to 176.16 aphids per day (av. 158.32). Gour (2001) reported that a male of *C. septempunctata* consumed mean 132.32 aphids per day whereas, the female beetle consumed 165.27 aphids per day. Singh *et al* (1994), Singh and Singh (1994) and Gour (2001) reported that order grubs consumed more aphids per day than the young grubs corroborate the present findings. The difference in consumption in aphid by larval and adult stage of C. *septempunctata* may probably be due to the difference in agro-climatic conditions of the locality which directly or indirectly affect the metabolic rate of individuals.

Syrphid fly, *Xanthogramma scutellarae*

Data presented in table 7 revealed that there were three instar maggot of syrphid fly, *X scutellarae* which lasted for 3, 3 and 4 days, respectively. Kulkarni and Patel (2001) reported three instars of maggot and total duration of larval instars of *X scutellarae.* varied from 8 to 11 days with an average of 9.39 days corroborate the present finding. It was observed that first, second and third instar maggot consumed 27.82, 174.21 and 253.15 aphids (nymph + adults) in the total maggot life span of 10 days. The rate of feeding among different maggot instars varied greatly. The third instar maggot consumed more number of aphids. An individual in order to complete its larval development on an average consumed 455.18 aphids. The work on the feeding potentiality of *Xanthogramma scutellarae* on *Lipaphis erysimi* was not available, therefore it could not be compared and discussed in detail.

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