Annals of Natural Sciences
Vol. 9(4), December 2023: 28-35
Journal's URL: http://www.crsdindia.com/ans.html
Email: crsdindia@gmail.com

e-ISSN: 2455-667X

Annals of Natural Sciences

ORIGINAL ARTICLE

Age Specific and Stage Specific Life Table of *Chilocorus circumdatus* Fabr (Coleoptera: Coccinellidae) on *Aphis craccivora* and *Lipaphis erysimi*

Arshad Ali
Department of Zoology, Gandhi Faiz-E-Aam College Shahjahanpur, Uttar Pradesh, India
Email: drarshadali@yahoo.com

ABSTRACT

To know the preference ladybird beetle Chilocorus circumdatus, two aphid species (Aphis craccivora and Lipaphis erysimi) were evaluated for the study of life table parameters (age and stage specific) under laboratory conditions. The observations on age specific life table showed that both aphid species were suitable for the development of ladybird beetle. However, the age of C. circumdatus was recorded maximum of 38 days on A. craccivora and 30 days L. erysimi, respectively. The stage specific life table exhibited survival and mortality of beetles at different developmental stages (egg, grub, pupa and adult). The comparative study showed that the data on mortality parameters (apparent mortality, mortality survival ratio, indispensable mortality, k-values, and total generation mortality) were recorded minimum on A. craccivora and maximum on L. erysimi. However, survival fraction of C. circumdatus was observed maximum on A. craccivora as compare to L. erysimi. Therefore, findings revealed that among two aphid species (A. craccivora and L. erysimi), ladybird beetle C. circumdatus showed highest preference on feeding of A. craccivora for their better growth and development under controlled environment.

Key words: *aphid, ladybird beetle, life expectancy, mortality, survival*

Received: 18th Oct. 2023, Revised: 22nd Nov. 2023, Accepted: 24th Nov. 2023

How to cite this article:
Ali A. (2023): Age Specific and Stage Specific Life Table of *Chilocorus circumdatus* Fabr (Coleoptera: Coccinellidae) on *Aphis craccivora* and *Lipaphis erysimi*. Annals of Natural Sciences, Vol. 9[4]: December, 2023: 28-35.

INTRODUCTION

Most of the coccinellidae beetles are predatory in nature, and are preying on soft bodied insects such as aphids, scale insects, mealy bugs, whiteflies, mites, eggs and small larvae of other insect etc [1]. Mostly, these soft bodied insects are the pest of agricultural crops and therefore, they considered as beneficial insects and also use as biological control agents [2]. However, some species feed on non-animal matter, fungi, and also on plants and considered as pest [3, 4].

Coccinellidae are cosmopolitan and commonly termed as ladybirds. More than 6000 species are spread throughout the world. Female beetle always laid eggs near the colony of their prey, which become food source for their grub on account of hatching. The metamorphosis is complete or holometabolous, and therefore, complete its life cycle through four stages *i.e.,* eggs, larvae, pupa and adult. Generally, they are oval with variable colors on dorsal surface but flattened black underside. Their size is variable from 0.8 - 18 mm [5]. Sexual dimorphism also occur and female is always slightly larger than the male. However, the larvae are elongated and body covered with hairs or setae with square head. The pupa is covered by the larval skin and is immobile. The length of each developmental stage depends on the climatic conditions, species of beetles and also on food provided to the beetles [2].

Among different prey of beetles, aphids are considered as most favorite food in nature [6]. But they are destructive pest of many agricultural crops and showed considerable loss in the yield. In view of the importance of ladybird beetle and aphid, present study therefore, designed on life table studies of a ladybird beetle *Chilocorus circumdatus* on two aphid species *i.e., Aphis craccivora* and *Lipaphis erysimi* to get the food preference.

MATERIALS AND METHODS

1. APHID CULTURE:

Two common aphid species *i.e.,* bean aphid, *A. craccivora* and and mustard aphid, *L. erysimi* ere collected from naturally infested field of common bean and mustard, respectively. Aphids were collected and bring to lab. for feeding of ladybird beetle daily.

2. LADYBEETLE CULTURE:

Among different ladybird beetles associated with aphids in the experimental field, adult beetles (both male and female) of *Chilocorus circumdatus* were collected and bring to the laboratory for the study of different life table parameters. They were paired and kept in petri dishes for mating. They mate many times and before egg laying a blotting paper was places in the inner surface of petri dish for egg laying.

The eggs laid by females were counted with respect to aphid species and transferred in other petri dishes. The eggs obtained from female *C. circumdatus* were collected to make cohort of hundred eggs. They were placed in petri dishes for hatching in the laboratory. The experiment replicated thrice for both the aphid species. On hatching, both the aphid species provided as food for newly hatched grub of *C. circumdatus* separately. Initially, counted number of aphid nymphs of both species was provided as food. Their size and number was increased with the advancement of age of the grub. They were shifted to the plastic vials on the moulting of grub, and reared separately for the study of different parameters of life table. This procedure was followed till pupation. After the emergence of adults (male and female), they were again provided with a minimum of 100 nymphs/ day till their death. Similar procedure was followed for the study of second generation.

3. LIFE TABLE CONSTRUCTION:

3.1. Age Specific Life Table:

Observations on number of alive and dead, out of hundred larvae were recorded daily. The following assumptions were used in the construction of age specific life-table of *C. circumdatus*.

x = Age of the insect in days,

l_x = Number surviving at the beginning of each interval, out of 100

d_x = Number dying during the age interval, out of 100

$100q_x$ = Mortality rate at the age interval x and calculated by using formula

$$100q_x = [d_x / l_x] \times 100$$

e_x = Expectation of life or mean life remaining for individuals of age x

Life expectation was calculated using the equation

$$e_x = T_x / l_x$$

To obtain e_x two other parameters L_x and T_x were also computed as below.

L_x = number of individuals alive between age x and x+1 and calculated by the equation.

$$L_x = l_x + 1 (x + 1) / 2$$

T_x = total number of individual of x age units beyond the age x & obtained by the equation;

$$T_x = l_x + (l_x + 1) + (l_x + 2) \ldots\ldots\ldots\ldots\ldots + l_w$$

Where, l_w = The last age interval

3.2. Stage Specific Life Table:

The data on stage specific survival and mortality of eggs, larvae, pupae and adults of *C. circumdatus* were recorded from the age specific life-table. Following standard heads were used to complete stage specific life table.

x = Stage of the insect.
l_x = Number surviving at the beginning of the stage x
d_x = Mortality during the stage indicated in the column x

The data calculated through above assumptions were used for computing various life parameters as given below:

3.2.1. Apparent Mortality (100 q_x):

It gives the information on number dying as percentage of number entering that stage and was calculated by using the formula:

Apparent Mortality = $[d_x / l_x] \times 100$

3.2.2. Survival Fraction (S_x):

Data obtained on apparent mortality was used for the calculation of the stage specific survival fraction of each stage by using the equation:

Sx of particular stage = [l_x of subsequent stage] / [l_x of particular stage].

3.2.3. Mortality Survivor Ratio (MSR):

It is the increase in population that would have occurred if the mortality in the stage, in question had not occurred and was calculated as follows:

MSR of particular stage = [Mortality in particular stage] / [l_x of subsequent stage]

3.2.4. Indispensable Mortality (IM):

This type of mortality would not be there in case the factor (s) causing it is not allowed to operate. However, the subsequent mortality factors operate. The equation is,

IM = [Number of adults emerged] x [M.S.R. of particular stage]

3.2.5. k-values:

It is the key factor, which is primarily responsible for increase or decrease in number from one generation to another and was computed as the difference between the successive values for "log l_x". However, the total generation mortality was calculated by adding the k-values of different development stages of the insect, which is designated/ indicated as "K.

$$K = k_E + k_{L1} + k_{L2} + k_{L3} + k_{L4} + k_P$$

Where, k_E, k_{L1}, k_{L2}, k_{L3}, k_{L4} and k_P are the k-values at egg, first instar, second instar, third instar, fourth instar and pupal stage of *C. circumdatus*.

RESULTS AND DISCUSSION

1. AGE SPECIFIC LIFE TABLE:

Age specific life table of *Chilocorus circumdatus* showed that it took longest development period of 38 days on *A. craccivora* as compare to *L. erysimi* (30 days). The mortality and survivorship exhibited a stair step like pattern with high and low peaks. The high peaks of mortality was recorded as 3, 3, 4, 9, 8, 14, 13, 16 and 10 on 1st, 6th, 32nd, 33rd, 34th, 35th, 36th, 37th and 38th day on *A. craccivora* and also as 8, 5, 3, 5, 4, 3, 4, 3, 4, 3, 8, 7, 5, 4, 11, 8 and 5 on 2nd, 3rd, 4th, 8th, 9th, 10th, 14th, 15th, 18th, 22nd, 25th, 26th, 27th, 28th, 30th, 31st and 32nd on *L. erysimi*, respectively (Table 1 & 2). The data on mortality showed highest mortality of *C. circumdatus* on *L. erysimi* as compared to *A. craccivora*. Similar trend of mortality and survival were also reported with respect to *C. septempunctata* by Naqvi [7] and Ali and Rizvi [8], on *Lemnia biplagiata* by Yu *et al.,* [9], on *Halyomorpha halys* by Govindan and Hutchison [10].

The observations on age specific life expectancy showed a continuous gradual drop in life expectancy (e_x) from day one to the death of *C. circumdatus* on both aphid species. A negligible increase in the e_x was recorded on 3rd and 4th day on *L. erysimi* but on *A. craccivora* marginal increase was nil, respectively (Table 1 & 2). The other workers of ladybird beetles [11, 12, 13 & 14] also recorded continuous decrease in the expectancy of life with advancement of age and given strengthen to the present statements.

2. STAGE SPECIFIC LIFE TABLE:

The data on stage specific life table includes survival and mortality of individuals at each developmental stage of *C. circumdatus* with respect to aphid species *i.e., A. craccivora* and *L. erysimi*.

1. Apparent Mortality:

The apparent mortality of *C. circumdatus* on different developmental stages showed comparative data *i.e.,* 13.00 and 6.00 % mortality at egg stage, 5.75 and 5.32 % at first instar, 17.07 and 4.49 % at second instar, 10.29 and 4.71 % at third instar, 3.28 and 1.23 % at fourth instar and 18.64 and 3.75 % at pupal stage on *L. erysimi* and *A. craccivora*, respectively (Table 3 & 4). The observation clearly revealed that highest mortality of *C. circumdatus* was observed on *L. erysimi* than *A. craccivora* at every developmental stage. The observations of Dargazani and Sahragard [15] and Khan *et al.,* [14] on *Harmonia axyridis* and *H. dimidiata* also showed similarity when fed on *Aphis gossypii* and *Rhopalosiphum padi*, respectively.

2. Survival Fraction:

As far as survival fraction was concerned, it attained high value of 0.94 and 0.87 at egg, 0.95 and 0.94 at first instar, 0.96 and 0.83 at second instar, 0.95 and 0.90 at third instar, 0.99 and 0.97 at fourth instar, 0.96 and 0.81 at pupal stage, on *A. craccivora* and *L. erysimi*, respectively (Table 3 & 4). The result showed highest survival of *C. circumdatus* on *A. craccivora* in contrast to *L. erysimi* at every developmental stage. The corroborative findings on the survival of ladybird beetles are Yu *et al.,* [9], Arshad *et al.,* [16] and Ramzan *et al.,* [17].

3. Mortality Survivor Ratio:

The ratio of mortality and survival of *C. circumdatus* recorded high value on *L. erysimi* at all the developmental stages; the comparative data on MSR is 0.15 and 0.06 at egg stage, 0.06 and 0.06 at first instar, 0.21 and 0.05 at second instar, 0.11 and 0.05 at third instar, 0.03 and 0.01 at fourth instar, and 0.23 and 0.04 at pupal stage on *L. erysimi* and *A. craccivora*, respectively (Table 3 & 4). The findings showed lowest MSR on *A. craccivora* which favour the higher growth of *C. circumdatus* at every developmental stage as compare to *L. erysimi*. Similar observations on mortality and survival of ladybird beetles were also reported by Yu *et al.,* [9], Khan *et al.,* [14] and Abbas *et al.,* [18].

4. Indispensable Mortality:

The indispensable mortality of *C. circumdatus* fed on *L. erysimi* and *A. craccivora* showed comparative observations on mortality as 0.18 and 0.08 at egg stage, 0.07 and 0.07 at first instar, 0.24 and 0.06 at second instar, 0.14 and 0.06 at third instar, 0.04 and 0.01 at fourth instar and 0.27 and 0.05 at pupal stage, respectively (Table 3 & 4). The mortality of *C. circumdatus* once again recorded maximum on *L. erysimi* than *A. craccivora* with respect to each developmental stage. The observation of Arshad *et al.,* [16] on the mortality *Hippodamia convergens* when fed on two aphid species, and findings of Ramzan *et al.,* [17] and Darwish [19] on *Coccinella undecimpunctata* fed on different aphid species also showed similar pattern of mortality and given strengthen to present result.

Table 1: Age specific survival and life expectancy of *C. circumdatus* on *A. craccivora*

x	l_x	d_x	$100q_x$	L_x	T_x	e_x
0	100	0	0.00	100.00	3799.00	37.99
1	100	3	3.00	98.50	2902.00	29.46
2	97	2	2.06	96.00	2803.50	29.20
3	95	1	1.05	94.50	2707.50	28.65
4	94	0	0.00	94.00	2613.00	27.80
5	94	0	0.00	94.00	2519.00	26.80
6	94	3	3.19	92.50	2425.00	26.22
7	91	1	1.10	90.50	2332.50	25.77
8	90	0	0.00	90.00	2242.00	24.91
9	90	2	2.22	89.00	2152.00	24.18
10	88	1	1.14	87.50	2063.00	23.58
11	87	0	0.00	87.00	1975.50	22.71
12	87	2	2.30	86.00	1888.50	21.96
13	85	0	0.00	85.00	1802.50	21.21
14	85	1	1.18	84.50	1717.50	20.33
15	84	1	1.19	83.50	1633.00	19.56
16	83	0	0.00	83.00	1549.50	18.67
17	83	0	0.00	83.00	1466.50	17.67
18	83	2	2.41	82.00	1383.50	16.87
19	81	1	1.23	80.50	1301.50	16.17
20	80	0	0.00	80.00	1221.00	15.26
21	80	0	0.00	80.00	1141.00	14.26
22	80	0	0.00	80.00	1061.00	13.26
23	80	2	2.50	79.00	981.00	12.42
24	78	1	1.28	77.50	902.00	11.64
25	77	0	0.00	77.00	824.50	10.71
26	77	1	1.30	76.50	747.50	9.77
27	76	0	0.00	76.00	671.00	8.83
28	76	1	1.32	75.50	595.00	7.88
29	75	0	0.00	75.00	519.50	6.93
30	75	1	1.33	74.50	444.50	5.97
31	74	0	0.00	74.00	370.00	5.00
32	74	4	5.41	72.00	296.00	4.11
33	70	9	12.86	65.50	224.00	3.42
34	61	8	13.11	57.00	158.50	2.78
35	53	14	26.42	46.00	101.50	2.21
36	39	13	33.33	32.50	55.50	1.71
37	26	16	61.54	18.00	23.00	1.28
38	10	10	100.00	5.00	5.00	1.00

Table 2: Age specific survival and life expectancy of *Chilocorus circumdatus* on *L. erysimi*

x	l_x	d_x	$100q_x$	L_x	T_x	e_x
0	100	0	0.00	100.00	3847.00	38.47
1	100	0	0.00	100.00	1871.00	18.71
2	100	8	8.00	96.00	1771.00	18.45
3	92	5	5.43	89.50	1675.00	18.72
4	87	3	3.45	85.50	1585.50	18.54
5	84	2	2.38	83.00	1500.00	18.07
6	82	0	0.00	82.00	1417.00	17.28
7	82	0	0.00	82.00	1335.00	16.28
8	82	5	6.10	79.50	1253.00	15.76
9	77	4	5.19	75.00	1173.50	15.65
10	73	3	4.11	72.00	1098.50	15.26
11	71	2	2.82	70.00	1026.50	14.66
12	69	0	0.00	69.00	956.50	13.86
13	69	0	0.00	69.00	887.50	12.86
14	69	4	5.80	67.00	818.50	12.22
15	65	3	4.62	63.50	751.50	11.83
16	62	2	3.23	61.00	688.00	11.28
17	60	0	0.00	60.00	627.00	10.45
18	60	4	6.67	58.00	567.00	9.78
19	56	2	3.57	55.00	509.00	9.25
20	54	1	1.85	53.50	454.00	8.49
21	53	0	0.00	53.00	400.50	7.56
22	53	3	5.66	51.50	347.50	6.75
23	50	1	2.00	49.50	296.00	5.98
24	49	0	0.00	49.00	246.50	5.03
25	49	8	16.33	45.00	197.50	4.39
26	41	7	17.07	37.50	152.50	4.07
27	34	5	14.71	31.50	115.00	3.65
28	29	4	13.79	27.00	83.50	3.09
29	25	0	0.00	25.00	56.50	2.26
30	25	11	44.00	19.50	31.50	1.62
31	14	8	57.14	9.50	12.00	1.26
32	5	5	100.00	2.50	2.50	1.00

5. k-values:

The k-value also represents the mortality of *C. circumdatus* at different developmental stage, it observed as 0.06 and 0.03 at egg stage, 0.03 and 0.02 at first instar, 0.08 and 0.02 at second instar, 0.05 and 0.02 at third instar, 0.01 and 0.01 at fourth instar and 0.09 and 0.02 at pupal stage on *L. erysimi* and *A. craccivora*, respectively (Table 3 & 4). However, K represents the total generation mortality and it also observed maximum as 0.32 on *L. erysimi* and minimum 0.11 on *A. craccivora* (Table 3 & 4). The record on generation

mortality of *Coccinella septempunctata* and *Coccinella undecimpunctata* observed on different host species by Yu *et al.,* [20] showed agreement with the present findings.

Table 3: Stage specific life table parameters of *Chilocorus circumdatus* on *Aphis craccivora*

Stages	No of surviving at beginning of stage	No. of dying in each stage	Apparent Mortality	Survival fraction	Mortality/ Survival ratio of stage	Indispensable Mortality		
x	l_x	d_x	100 q_x	S_x	MSR	IM	Log l_x	k-values
Egg	100	6	6.00	0.94	0.06	0.08	2.00	0.03
1st Instar	94	5	5.32	0.95	0.06	0.07	1.97	0.02
2nd Instar	89	4	4.49	0.96	0.05	0.06	1.95	0.02
3rd Instar	85	4	4.71	0.95	0.05	0.06	1.93	0.02
4th Instar	81	1	1.23	0.99	0.01	0.01	1.91	0.01
Pupa	80	3	3.75	0.96	0.04	0.05	1.90	0.02
Adult	77	77	100.00	0.00	--	--	1.89	--
								K = 0.11

Table 4: Stage specific life table parameters of *Chilocorus circumdatus* on *Lipaphis erysimi*

Stages	No of surviving at beginning of stage	No. of dying in each stage	Apparent Mortality	Survival fraction	Mortality/ Survival ratio of stage	Indispensable Mortality		
x	l_x	d_x	100 q_x	S_x	MSR	IM	Log l_x	k-values
Egg	100	13	13.00	0.87	0.15	0.18	2.00	0.06
1st Instar	87	5	5.75	0.94	0.06	0.07	1.94	0.03
2nd Instar	82	14	17.07	0.83	0.21	0.24	1.91	0.08
3rd Instar	68	7	10.29	0.90	0.11	0.14	1.83	0.05
4th Instar	61	2	3.28	0.97	0.03	0.04	1.79	0.01
Pupa	59	11	18.64	0.81	0.23	0.27	1.77	0.09
Adult	48	48	100.00	0.00	--	--	1.68	--
								K = 0.32

CONCLUSION

The overall studies on age specific life table parameters of *Chilocorus circumdatus* showed that both the aphid species (*A. craccivora* and *L. erysimi*) are suitable as food for the growth and development of ladybird beetle. However, the parameters of stage specific life table showed that all the developmental stages of *C. circumdatus* attained lowest mortality and highest survival on *A. craccivora* as compare to *L. erysimi*. Therefore, present findings concluded *C. circumdatus* showed highest preference on *A. craccivora* for growth and development under controlled environment.

ACKNOWLEDGMENT

Author is highly grateful to Professor Samiran Chakraborty, Department of Zoology, University of Kalyani, West Bengal, for identifying aphid species.

REFERENCES

1. Kundoo A.A. and Khan A.A. (2017): Coccinellids as biological control agents of soft bodied insects: A review. J Entomol Zool Stud, 5(5): 1362-1373.
2. Kuznetsov V.N. and Hong P. (2002): Employment of Chinese Coccinellids in biological control of aphids in green house. J Far East Entomol, 119: 1-5.
3. Blackman R.L. and Eastop V.F. (2000): Book review-Aphids on the worlds herbaceous plants and shrubs. Wiley, Chichester, pp: 1439.
4. Khursheed S., Bhat Z.A., Rather G.H., Itoo H., Malik A.R. and Pandit B.A. (2021): Occurrence of insect and mite pests and their natural enemies under high density apple agro-ecosystems in Kashmir. J Entomol Zool Stud, 9(1): 993-998.
5. Rai M.K., Ramamurthy V.V. and Singh P.K. (2002): Biological attributes and morphmetrics of *Coccinella septempunctata* (L.) (Coleoptera: Coccinellidae). Ann Pl Protec Sci, 10: 194-197.
6. Hodek I., Van Emden H.F. and Honek A. (2012): Ecology of Coccinellidae. Wiley-Blackwell, Dordrecht.
7. Naqvi N.A. (2003): Insect pest management strategies in *Brassica compestris* variety brown sarson with special reference to bio-ecological studies on potential predators of *Lipaphis erysimi* (Kaltenbach). Ph.D. thesis: Department of Plant Protection, Aligarh Muslim University, Aligarh, pp: 110.
8. Ali A. and Rizvi P.Q. (2010): Age and stage specific life table of *Coccinella septempunctata* (Coleoptera: Coccinellidae) at varying temperature. World J Agric Sci., 6(3): 268-273.
9. Yu J.Z., Chi H. and Chen B.H. (2005): Life table and predation of *Lemnia biplagiata* (Coleoptera: Coccinellidae) fed on *Aphis gossypii* (Homoptera: Aphididae) with a proof on relationship among gross reproduction rate, net reproduction rate, and preadult survivorship. Ann Entomol Soc Am, 98: 475-548.
10. Govindan B.N. and Hutchison W.D. (2020): Influence of temperature on age-stage, two-sex life tables for a Minnesota-acclimated population of the brown marmorated stink bug (Halyomorpha halys). Insects, 11(2): 108. https://doi.org/10.3390/insects11020108
11. Chi H. and Yang T.C. (2003): Two-sex life table and predation rate of *Propylaea japonica* Thunberg (Coleoptera: Coccinellidae) fed on *Myzus persicae* (Sulzer) (Homoptera: Aphididae). Environ Entomol, 32: 327-333.
12. Ali A. and Rizvi P.Q. (2007): Age specific survival and fecundity table of *Coccinella septempunctata* L. (Coleoptera: Coccinellidae) on different aphid species. Ann Pl Protec Sci, 15: 329-334.
13. Castro C.F., Almeida L.M. and Penteado S.R.C. (2011): The impact of temperature on the biological aspects and life table of *Harmonia axyridis* (Pallas) (Coleoptera: Coccinellidae). J Florida Entomol, 94(4): 923-932.
14. Khan J., Khan A., Ahmed N., Alhag S.K., Almadiy A.A., Sayed S., Alam P. and Ullah F. (2022): Age and stage-specific life table parameters of *Harmonia dimidiata* (Coleoptera: Coccinellidae) fed on *Rhopalosiphum padi* (Hemiptera: Aphididae) at different temperatures. Egyptian J Biol Pest Control, 32: 113, https://doi.org/10.1186/s41938-022-00610-x
15. Dargazani B. and Sahragard A. (2020): Life table and predation rate of *Harmonia axyridis spectabilis* (Col., Coccinellidae), fed on *Aphis gossypii* (Hem., Aphididae). Archiv für Phytopathologie und Pflanzenschutz, 53(5-6): 282-297.
16. Arshad M., Ullah M.I., Shahid U. Tahir M., Khan M.I., Rizwan M., Abrar M., and Niaz M.M. (2020): Life table and demographic parameters of the coccinellid predatory species, *Hippodamia convergens* Guérin-Méneville (Coleoptera: Coccinellidae) when fed on two aphid species. Egypt J Biol Pest Control, 30: 79. https://doi.org/10.1186/s41938-020-00280-7
17. Ramzan Z., Khursheed S., Manto M.A., Itoo H., Naseem N., Bhat F.A.. Rather G.H., Bhat Z.A., Mir M.A., Wani F.J., and Ganie S.A. (2023): Life table and reproductive parameters of ladybird beetle, *Coccinella undecimpunctata* (Linnaeus) (Coleoptera: Coccinellidae) on aphids, *Myzus persicae* (Sulzer) and *Brevicoryne brassicae* (Linnaeus) (Hemiptera: Aphididae). J Entomol Res Soc, 25(3): 507-519.
18. Abbas K., Zaib M.S., Zakria M., Hani U.E., Zaka S.M. and Ain N.U. (2020): Age-stage, two-sex life table of the *Menochilus sexmaculatus* (Coccinellidae: Coleoptera) feeding on different aphid species. bioRxiv, https://doi.org/10.1101/2020.01.15.907576
19. Darwish A.A. (2019): Stage-specific life table parameters of *Coccinella septempunctata* Linnaeus and *Coccinella undecimpunctata* Linnaeus (Coleoptera: Coccinellidae) on different host species under laboratory conditions. Egypt Aca J Biolog Sci, 12(3): 37- 47.
20. Yu J.Z., Chi H. and Chen B.H. (2013): Comparison of the life tables and predation rates of *Harmonia dimidiata* (F.) (Coleoptera: Coccinellidae) fed on *Aphis gossypii* Glover (Hemiptera: Aphididae) at different temperatures. Biol Contr, 64: 1-9. https://doi.org/10.1016/j.biocontrol.2012.10.002