

LIFE TABLE STUDIES OF *COCCINELLA SEPTEMPUNCTATA* LINNEOUS ON NATURAL DIETS

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ABSTRACT: Laboratory experiment was conducted to determine the life table studies of *Coccinella septempunctata* (Lin.) on fresh, frozen and dried mustard aphid at Department of Plant Protection, SAU, Tandojam, Sindh, Pakistan during 2013-14. The findings of present studies indicated that the larvae of the predator fed with dried aphid were suffered with highest mortality (d_x), apparent mortality (S_x), indispensable mortality (IM) in larval and pupal stage. The adults emerged from the pupae also produces weaker egg, maximum of them were failed to hatch. The highest apparent mortality ($100q_x$) was observed in all life stages of the predator on dried and minimum on fresh aphids. The highest number of the survivor (l_x) 36 adults was recorded on fresh aphid followed by 26 and 18 on frozen and dried aphids, respectively. The minimum total generation mortality (K - value) was recorded as (0.14) on fresh aphid followed by 0.28 and 0.44 on frozen and dried aphids, respectively. The shorter life period (days) was recorded on fresh aphid and longer on dried aphid. It is concluded that dried aphids are not fit for mass rearing of *C. septempunctata*, however, during the period of natural diets scarcity frozen aphids are better for mass rearing

Keywords: *Coccinella septempunctata*, Mustard aphid, Life table.

INTRODUCTION

Biological control is major component of Integrated Pest Management (IPM) strategy. In this management practice many entomophagous insects including predators and parasitoids to be released for the suppression of insect pests, which are serious threat to our crops. It depends on the efficiency of natural enemies, which possess the quality of reproduction, best foraging ability for its prey, better survivor in various abiotic factors [1,2]. In the agroecosystem majority of lady beetles are predators both adults and larva feed on soft bodied insect pests. Some well-known species of coccinellid i.e. *Hippodamia convergens*, *Coccinella septempunctata*, *Coccinella transversalis*, *Coccinella undecimpunctata*, *Brumus sutuvaralis* and *Menochilus sexmaculatus* are common predators of arthropod insect pests of many crops [3;4,5]. This is abundant in a wide range of Eurasian, African and now also North American agroecosystems, preying upon several economically important aphid species. In Europe the populations of this coccinellid have been intensively studied [6;7;8]. Life table provide comprehensive information about population fluctuation about related insect species and development, survivorship and expectancy in the life [9]. Though, life table carried out under laboratory condition that provide basic information for researchers to obtain the data regarding for life table analysis to assess its impact on their existence under exact circumstances, the same data provided the comprehensive knowledge on other factors to develop models for field conditions. Development rate and fecundity of organism may influenced by change in nutrients and food preferences [10]. Therefore, this life table studies of *C. septempunctata* Linnous on natural diets was constructed to determined their development, survivor and mortality in the laboratory conditions.

MATERIALS AND METHODS

The experiment was conducted to determine the life table studies of *Coccinella septempunctata* Linn. On natural diets in the laboratory of Plant Protection Department, Sindh Agriculture University, Tando Jam, at $26 \pm 2^\circ\text{C}$ temperature and $65 \pm 5\%$ relative humidity and photoperiod (11 L: 13 D) during 2013-14. The adult beetles were collected from different crops and reared on natural host species in the laboratory for stock culture. There was three treatments including T_1 = Fresh mustard aphid, T_2 = Frozen mustard aphid, T_3 = Dried mustard aphid with five replicates. Live mustard aphid was collected from the host crop. These aphids were preserved into two ways (i) Frozen aphid and (ii) Dried aphid.

FROZEN APHID

Live aphids were collected from respective host plants with the help of suction pump brought in the laboratory. These aphids were placed in the freezer at temperature 0°C in plastic box (20×8 cm) for 24 hrs. When aphids completely frozen, the dead aphids were taken and keeping into small boxes on same temperature. The frozen aphids were provided to predator to determine the biological parameters.

DRIED APHID

The collected live aphids were killed at low temperature by placing them in freezer for 24 hrs. The dead aphids were placed in the oven at 50°C for 3-4 hrs. The dried aphids were stored by keeping them in a plastic container and kept at 20°C in the refrigerator till the experimentation. The experimental design was Completely Randomized Design (CRD). For the experiment 50 eggs of the beetle was obtained from stock culture and was kept in the Petri dishes separately.

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:

Apparent Mortality (100q)

Apparent Mortality = $[d / l] \times 100$

Survival Fraction (Sx)

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

Mortality Survivor Ratio (MSR)

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

Indispensable Mortality (IM)

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

K-values

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

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

RESULTS**APPARENT MORTALITY (100QX)**

The result given in Table 1 indicated that the highest apparent mortality was observed 14.0 % at egg stage when fed on dried aphid followed by 10 and 8 % mortality was recorded on frozen and fresh aphids, respectively. Similarly, the lowest mortality was recorded 6.52 % when fed on fresh aphid followed by 13.33 and 18.60 % was recorded in the 1st larval instar reared on frozen and dried aphids, respectively. The highest mortality was occurred in the 2nd instar larvae 17.14 % fed on dried aphid followed by 10.26 and 4.65 % fed with frozen and fresh aphids, respectively. Similarly, the highest mortality was seen in the 3rd instar larval stage 13.79 % fed on dried aphid followed by frozen and fresh aphids 8.57 and 4.88 %, respectively. The highest mortality was observed in 4th instar larvae 3.0 % on frozen aphids followed by 2.0 % was recorded when reared on fresh as well as dried aphids. The results further revealed that the maximum apparent mortality was recorded in the pre-pupa 2.0 and 1.0 fed on dried and frozen aphids. The highest pupal mortality was recorded 3.0 % on dried aphids followed by 2.0 and 1.0 % when reared on frozen and fresh aphids, respectively. The data further depicted that the highest survival was recorded in adults 36.0 fed on fresh aphid followed by 26.0 and 18.0 % reared on frozen and dried aphids, respectively. In the light of above mentioned results it was observed that the highest apparent mortality found in the 1st instar larvae on 18.0 % fed on the dried aphids and lowest was 3.0 % when reared on fresh aphids.

SURVIVAL FRACTION (SX)

The result presented in Table 1 depicted that in the maximum survival fraction in the egg stage was recorded 0.92 when fed on fresh aphid followed by 0.90 and 0.86 on frozen and dried aphids, respectively. The result further revealed that the highest Sx was seen in the 1st instar larva 0.93 on fresh aphid followed by 0.87 and 0.81 on frozen and dried aphids, respectively. Similarly, the highest survival fraction Sx was recorded 0.95 in the 2nd instar on fresh aphids followed by 0.90 and 0.83 % was recorded on frozen and dried aphids, respectively. The 3rd instar larvae showed the highest survival fraction 0.95 reared on fresh aphid followed by 0.91 and 0.86 on frozen and dried aphids, respectively. In 4th instar larvae highest Sx was found 0.95 fed on fresh aphid followed by 0.92 and 0.91 survival fraction Sx was obtained when reared

on dried and frozen aphids, respectively. The result further revealed that the highest Sx was obtained in the pre-pupa 1.0 fed on fresh aphid followed by frozen and dried aphids 0.97 and 0.91, respectively. Similarly, the highest Sx was recorded 0.97 in the pupal stage reared on fresh aphid followed by 0.93 and 0.91 fed with frozen and dried aphids, respectively. In the light of above described results it was observed that the highest survival fraction Sx was obtained in the 2nd, 3rd and 4th instar larvae reared on fresh aphid, whereas, lowest Sx was recorded 1st instar larva on dried aphid. The result further depicted that the highest survivor fraction Sx was seen in pre-pupal and pupal stages reared on fresh aphid and lowest was obtained on dried aphid.

MORTALITY SURVIVOR RATIO (MSR)

The result presented in Table 1 showed that the maximum mortality survivor ratio was recorded 0.16 in egg stage on dried aphid followed by 0.11 and 0.09 on frozen and fresh aphids, respectively. The further indicated that maximum MSR was seen 0.23 in the 1st instar larvae reared on dried aphid followed by frozen and fresh aphids 0.15 and 0.07, respectively. The 2nd instar larvae showed maximum MSR 0.21 on dried aphid followed by 0.11 and 0.05 when fed on frozen and fresh aphids, respectively. Similarly the maximum MSR was obtained in the 3rd instar larvae 0.16 on dried aphid followed by frozen and fresh aphids 0.09 and 0.05, respectively. The maximum MSR was recorded in the 4th instar larvae 0.10 reared on frozen aphid followed by 0.9 and 0.05 on dried and fresh aphids. The result further revealed that the maximum MSR was found in the pre-pupal stage 0.10 on dried aphid and 0.04 on frozen aphid. Similarly, in the pupal stage maximum MSR was recorded 0.17 on dried aphid followed by 0.08 and 0.03 were recorded on frozen and fresh aphids. It is observed from the above findings that the maximum MSR was recorded in the 1st instar larvae on dried, whereas, the minimum MSR was obtained 2nd, 3rd and 4th instars on fresh aphid.

INDISPENSABLE MORTALITY (IM)

The data prescribed in Table 1 revealed that the highest indispensable mortality IM was occurred at egg stage 7.0 fed on dried aphid followed by 5.0 and 4.0 on frozen and fresh aphid, respectively. The result further indicated that the minimum IM in the 1st instar larva was observed 3.0 reared on fresh aphid followed by 6 and 8, respectively. Hence, 2nd larval instar indicated the maximum IM was 6.0 on dried aphid followed by 4.0 and 2.0 when fed with frozen and fresh aphids, respectively. The 3rd instar larva showed the highest indispensable mortality 4.0 on dried aphids followed by 3.0 and 2.0 on frozen and fresh aphids, respectively. Similarly, in the 4th instar larva maximum IM was recorded 3.0 on frozen aphid and 2.0 was recorded when fed on fresh as well as dried aphids, respectively. The result further indicated that the pre-pupa showed maximum IM 2.0 on dried aphid and minimum on 1.0 on frozen aphid. Similarly, the maximum IM was observed 3.0 in the pupal stage reared on dried aphid followed by 2.0 and 1.0 fed on frozen and fresh aphids, respectively. It was observed that the highest indispensable mortality was recorded in 1st instar larvae when reared on

was observed 0.07 on dried aphid followed by 0.03 and 0.01

Table.1 Life table of <i>Coccinella septempunctata</i> on mustard aphid, <i>Lipaphis erysimi</i> under laboratory conditions.								
Stage x	No. surviving at the beginning of stage lx	No. dying in each stage dx	Apparent mortality 100qx	Survival fraction Sx	Mortality survivor ratio MSR	Indispensable mortality IM	Log lx	k-Value
Fresh aphid								
Egg	50	4	8.00	0.92	0.09	4.00	1.70	0.04
1 st instar	46	3	6.52	0.93	0.07	3.00	1.66	0.03
2 nd instar	43	2	4.65	0.95	0.05	2.00	1.63	0.02
3 rd instars	41	2	4.88	0.95	0.05	2.00	1.61	0.02
4 th instar	39	2	5.13	0.95	0.05	2.00	1.59	0.02
Pre-pupa	37	0	0.00	1.00	0.00	0.00	1.57	0.00
Pupa	37	1	2.70	0.97	0.03	1.00	1.57	0.01
Adult	36	36	100.00	-----	-----	-----	1.56	-----
								0.14
Frozen aphid								
Egg	50	5	10.00	0.90	0.11	5.00	1.70	0.05
1 st instar	45	6	13.33	0.87	0.15	6.00	1.65	0.06
2 nd instar	39	4	10.26	0.90	0.11	4.00	1.59	0.05
3 rd instars	35	3	8.57	0.91	0.09	3.00	1.54	0.04
4 th instar	32	3	9.38	0.91	0.10	3.00	1.51	0.04
Pre-pupa	29	1	3.45	0.97	0.04	1.00	1.46	0.02
Pupa	28	2	7.14	0.93	0.08	2.00	1.45	0.03
Adult	26	26	100.00	-----	-----	-----	1.41	-----
								0.28
Dried aphid								
Egg	50	7	14.00	0.86	0.16	7.00	1.70	0.07
1 st instar	43	8	18.60	0.81	0.23	8.00	1.63	0.09
2 nd instar	35	6	17.14	0.83	0.21	6.00	1.54	0.08
3 rd instars	29	4	13.79	0.86	0.16	4.00	1.46	0.06
4 th instar	25	2	8.00	0.92	0.09	2.00	1.40	0.04
Pre-pupa	23	2	8.70	0.91	0.10	2.00	1.36	0.04
Pupa	21	3	14.29	0.86	0.17	3.00	1.32	0.07
Adult	18	18	100.00	-----	-----	-----	1.26	-----
								0.44

dried aphid and lowest in the pre-pupal and pupal stages. **K-VALUE**

The result depicted in Table 1 showed that the lowest k value was recorded 0.04 at egg stage fed on fresh aphid followed by 0.05 and 0.07 on frozen and dried aphid respectively. The data further revealed that the highest k value was observed in the 1st instar larva 0.09 on dried aphid followed by 0.06 and 0.03 was recorded on frozen and fresh aphid, respectively. Similarly, in the 2nd instar larva the highest k value was recorded 0.08 when fed on dried aphid followed by 0.05 and 0.02 on frozen and fresh aphid, respectively. The highest k value was observed in the 3rd instar larvae 0.06 on dried aphid followed by 0.04 and 0.02 were recorded on frozen and fresh aphids, respectively. Similarly, the highest k value was recorded 0.04 in the 4th instar larva when fed on dried and frozen aphids and lowest was seen 0.02 on fresh aphid. It was observed that the highest k value was recorded in the 1st instar larvae when fed with dried aphid, whereas, the lowest was seen in the 2nd, 3rd and 4th instar larvae reared on fresh aphid. The result further depicted that the highest k value was observed in the pre-pupal stage 0.04 and lowest was 0.02 on frozen aphid. Similarly, in the pupal stage the highest k value

on frozen and fresh aphids, respectively. The lowest K value was recorded 0.14 on fresh aphid followed by 0.28 and 0.44 when fed on frozen and dried aphid, respectively.

DISCUSSION

The findings of our present result indicated that the maximum egg hatching percentage, adult emergence, survivor of immature and adult stages was obtained on fresh aphid, respectively, whereas, minimum egg hatching, adult emergence, less survivorship occurred in both adult as well immature stages on dried aphid, respectively. The shortest incubation, development period of immature stages and pre-pupal and pupal period in days was recorded on fresh aphid, respectively, however longest was recoded on dried aphid, respectively. The findings of present result have more or less agreements with [11] who reared *C. septempunctata* L. on cereal aphid, *S. avenae*, the maximum hatchability was observed 81.89 % with a range 70-90 %. The findings of present result corroborated with [12] reported that the biotic potential of coccinellid predators *Coccinella septempunctata*, *C. transversalis* and *Cheilomenes*

sexmaculata on aphids *Aphis craccivora*, *A. gossypii*, *A. nerii*, *Lipaphis erysimi*, *Rhopalosiphum maidis* and *Uroleucon compositae*. These three coccinellid predators accepted all the hosts, but *U. compositae* was the least preferred resulting in no egg production in *C. septempunctata* and *C. transversalis*. Developmental period of *C. septempunctata* and *C. transversalis* varied from 16.5 to 21.4 and 15.2 to 18.0 days, respectively. *C. sexmaculata* predated voraciously and bred well on all these hosts including *U. compositae*, indicating its wide host range. But, it developed faster on *A. nerii* (12.2 days) than other hosts and was more fecund on *A. craccivora* and *A. nerii*. *A. craccivora* was the most preferred host for all the coccinellids. The findings our present study are in line with [13] reported life history traits and demographic attributes of *C. septempunctata* were determined using seven different diets with different alternations and proportions of an aphid, *Lipaphis erysimi* (Kaltenbach) and a mite, *Tetranychus urticae* Koch, in the laboratory (at 25 +/- 0.58 degrees C, 65 +/- 5% RH and a photoperiod of 16 h L: 8 h D). Life expectancy (e(x)) was highest (111 days) when adults were fed only aphids and lowest (11.3 days) when fed only mites. Survival rates of ladybird beetles were positively related to an increasing ratio of aphids in their diet. Their ability to prey on both aphids and mites indicates the effectiveness of *C. septempunctata* as a biological control agent on plants infested with these two pests. This also partially agreed with the findings of [14] evaluated natural and alternative artificial foods on seven spotted ladybird beetle, *Coccinella septempunctata* L., a natural enemy of aphids. Both larvae and adults of *C. septempunctata* fed on aphid and artificial diet, the predator normally completed its development from egg to adulthood in 20.6 days on aphid prey, in contrast to 29.0 days, when fed on artificial diet.

CONCLUSION

The maximum adult emergence, egg hatching, larval, prepupal and pupal survival (lx) were found on fresh aphid followed by frozen and dried aphids, respectively. The maximum mortality (dx) was observed in 1st instar larva when fed with dried aphid. The lowest K value and highest survivor was recorded on fresh aphid followed by frozen and dried aphids, respectively.

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