Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

Journal of Entomology and Zoology Studies

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2019; 7(5): 1321-1323

Received: 13-07-2019
Accepted: 15-08-2019

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Biology and life table parameters of *Myzus persicae* Sulzer (Hemiptera: Aphididae) in cauliflower, *Brassica oleracea* var. *botrytis*

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Abstract
Aphid complex was a serious problem in cruciferous vegetables causing about 50 to 67 per cent of yield loss. Among which *Myzus persicae* was the first one to appear in both the cropping seasons and remained till the harvest. The experiment was carried out to study the biology and life table parameters of *M. persicae* in cauliflower plants under ambient conditions. The biological parameters observed were the duration of nymphal stage, life cycle, adult longevity, and fertility. The life expectancy of aphid in cauliflower was 19 days with a total nymphal period of 5.24 days (I instar-1.46 days, II instar-1.68 days, III instar-1.32 days, IV instar-0.88 days) and adult longevity of 12.84 days. The larviposition started at 7th day and continued for the next 12 days. The net reproductive rate (R_o) of individual female in her lifetime was 24.40 with a generation time of (T) 10.25 days. The determined intrinsic rate of natural increase (R_m) and the finite rate of increase (λ) were 0.312 and 1.366 no/day, respectively. The population doubling time was found to be 2.223 days.

Keywords: Cauliflower, fertility, life table, longevity, *Myzus persicae*

Introduction
Cauliflower (*Brassica oleraceae* L. var. *botrytis*) originated from the island of Cyprus is the most important and delicate vegetable of the Brassicaceae family [4]. It follows cabbage in regard to area and production in the world, however in India cauliflower is more widely grown than cabbage (4.5 lakh ha and 6.6 million MT of area and production) [7]. Aphid complex is considered as a serious problem in cruciferous vegetable cultivation either directly by draining the phloem sap or by transmitting viral diseases which reduces its yield potential of about 50-67 per cent [3, 11]. Among this, *Myzus persicae* Sulzer is the most diverse and polyphagous agricultural pest (hundreds of host species from over 40 families) where infestation starts from seedling stage to harvest in both the cropping seasons [2]. Like other aphids, it reproduces parthenogenetically during the summer with short generation time and so population increases rapidly under favorable conditions. The increasing population density causes winged morphs to appear. *M. persicae* sometimes cause direct feeding damage with its toxic saliva or indirectly by transmitting viral diseases (e.g. Cauliflower mosaic, Turnip mosaic) and secreting honeydew [14, 10]. The damage symptoms include chlorotic spots, dwarfing, wilting, curling and yellowing of leaves. High population densities can lead to water stress, reduced growth and finally to decreased yield.
A life table is an important analytical tool in studying distribution, determination of specific age and calculation of individual mortality. Life table parameters help to identify the changes in the population of insect pests during each developmental stage and throughout their life cycle [9]. A key factor responsible for the highest mortality can be analyzed and used in insect pest management.
The present study was designed to provide data on the developmental period and fecundity rate of *M. persicae* that might be used for developing integrated pest management strategies.

Materials and Methods
Laboratory culture of *M. persicae* was reared on 5-6 weeks old pot cultured cauliflower plants (Arka Kanti) at ambient temperature (34 ± 2 ^{0}C and 60% RH). The growth and development of *M. persicae* were monitored using the clip-cage method. Fifty numbers of gravid adults were clip-caged individually at the rate of four clip-cages per plant.

Each cage was clipped on the expanded leaf surface and the adults were released on the lower surface of the leaf. The cages were changed to another leaf at four days interval to avoid the leaf damage. Once the new nymphs were laid the adults were removed. The observations on the duration of each nymphal instar were recorded every 24 hours using a magnifying lens. After attaining the adult stage, the number of nymphs larviposited per adult was recorded daily by removing the nymphs with the help of camel-hair brush after each counting. The readings on developmental time (duration of nymphal stages), adult longevity (pre-reproductive, reproductive and post-reproductive period), total life cycle (sum of developmental time and longevity period) and fertility (number of off-springs produced with the life of an adult) were observed to study the biology of aphids [8].

In order to construct a life table, age-specific survival and age-specific fecundity at each pivotal age were worked out daily for the entire life period. Life table parameters *viz.*, intrinsic rate of increase (r_m: the rate of progeny production per female per day), finite rate of increase (λ: the number of individuals added to the population per head per unit time or number of births per female per day), net reproductive rate (R_0: the number of times that the population would multiply by the end of each generation), gross reproductive rate (GRR: the number of females produced per female), mean generation time (T: the time required to complete a generation) and doubling time (t: time required for doubling the population) were determined.

Results and Discussion

The developmental time of four nymphal instars of *M. persicae* was 1.46, 1.68, 1.32 and 0.88 days, respectively. The total nymphal period was 5.34 days and the first nymphal mortality started from 4th pivotal age (Table 1). The age of the first larviposition was observed on 7th pivotal age and continues for the next 12 days. The fifty percent larviposition was recorded on 12th day and the maximum fertility on 10th pivotal age. The last larviposition was recorded on 18th pivotal age with the rate of 1.36 nymphs per adult and after that, all the females were found dead. The adult longevity was 13.48 days with a pre-reproductive, reproductive and post-reproductive period of 0.72, 11.86 and 0.90 days, respectively (Table 2).

The fertility rate of per female per day was 2.58 with the gross reproductive rate (GRR) of 30.891. The net reproductive rate (R_0) was calculated to be 24.40 numbers of females per lifetime. The difference in net reproductive rate and the gross reproductive rate was explained on the basis of declining survivorship value (l_x) for the adult females since most of the females have died earlier than the maximum life span of 19 days (Fig 1). The innate capacity for the natural increase of aphid (r_c) calculated was 0.286 whereas the true intrinsic rate of natural increase was (r_m) 0.312. The finite rate of increase (λ) determined was 1.366 nymphs per day. The mean generation time of the species was 10.25 days and the time required for doubling the population was 2.223 days (Table 3).

Similarly, the intrinsic rate of increase for *M. persicae* was reported as 0.153 which was lower than the present study and the population doubling time in cauliflower was recorded as 4.53 days [12]. In the same way, the intrinsic rate of increase of the same species in apricot was 0.148, 0.243 and 0.490 whereas in peach it was 0.153, 0.242 and 0.485 at different constant temperatures of 20, 24 and 28 ^{0}C, respectively [1]. The difference may be attributed to the effect of temperature and host plants which increases the rate of development and decreases the time period to double the population level. The developmental time of the aphid was longer and varied on different host plants [13]. Significant effect of temperature and different hosts on survival, fecundity and developmental times of *Bemisia argentifolii* was also reported [5]. The currant-lettuce aphid, *Nasonovia ribisnigri* was sensitive to fluctuating temperatures and their developmental time, survival and fecundity were affected at increasing temperatures [6].

Table 1: Age-specific fecundity and life table of *Myzus persicae*

x	s_x	l_x	m_x	l_xm_x	xl_xm_x	$100q_x$
0	50	1	0	0	0	0
1	50	1	0	0	0	0
2	50	1	0	0	0	0
3	50	1	0	0	0	0
4	50	1	0	0	0	2.00
5	49	0.98	0	0	0	4.08
6	47	0.94	0	0	0	2.13
7	46	0.92	2.93	2.70	18.90	4.35
8	44	0.88	3.02	2.66	21.28	0.00
9	44	0.88	3.11	2.74	24.66	0.00
10	44	0.88	3.32	2.92	29.20	2.27
11	43	0.86	3.23	2.78	30.58	0.00
12	43	0.86	2.81	2.42	29.04	0.00
13	43	0.86	2.91	2.50	32.50	13.95
14	37	0.74	2.59	1.92	26.88	10.81
15	33	0.66	2.52	1.66	24.90	6.06
16	31	0.62	1.74	1.08	17.28	12.90
17	27	0.54	1.33	0.72	12.24	59.26
18	11	0.22	1.36	0.30	5.40	100.00
19	0	0	0	0	0	0

x- Pivotal age in days; s_x-Number of females surviving at beginning of *x*; l_x-Proportion of females surviving at beginning of *x*; m_x-Number of females produced per female; l_xm_x-Reproductive expectation; $100q_x$-Rate of mortality

Table 2: Biology of *Myzus persicae* in cauliflower

Parameters		Days (Mean ± S. E)
Duration of the nymphal stage	I instar	1.46 ± 0.50
	II instar	1.68 ± 0.59
	III instar	1.32 ± 0.62
	IV instar	0.88 ± 0.63
Total nymphal period		5.34 ± 1.21
Pre-reproductive period		0.72 ± 0.67
Reproductive period		11.86 ± 1.47
Post-reproductive period		0.90 ± 0.68
Adult longevity		13.48 ± 1.68
Fertility/female/day		2.58 ± 0.76
Total life span		18.82 ± 2.31

All values are mean of 50 observations ± S. E.

Table 3: Life table parameters of *Myzus persicae* in cauliflower

Gross reproductive rate (GRR)	$GRR = \sum m_x$	30.891
Net Reproductive Rate (R_o) (no./female/lifetime)	$R_0 = \sum l_x m_x$	24.40
Generation Time (T) (days)	$T = \frac{log_e R_0}{r_m}$	10.25
Innate capacity for increase (r_c)	$r_c = \frac{log_e R_0}{T_c}$	0.286
Intrinsic Rate of Increase (r_m)	$r_m = \text{minus of } \text{Ln}(\frac{e^{-r_m x}}{x})$	0.312
Finite rate of increase (λ) (no./day)	$\lambda = e^{r_m}$ or $\lambda = antilog_e r_m$	1.366
Doubling time (t) (days)	$t = \frac{log_e 2}{r_m}$	2.223

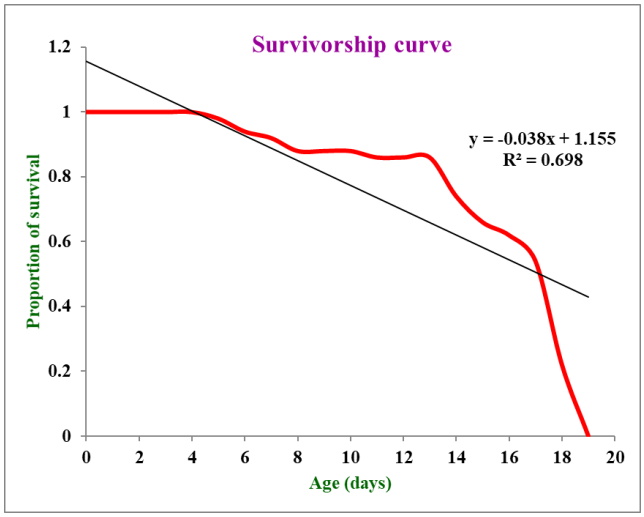

Fig 1: Age-specific survivorship (l_x) curve of *Myzus persicae*

Conclusion

The intrinsic rate of increase (r_m) and the doubling time (t) indicated that *M. persicae* can increase to a considerable extent and can cause serious yield loss in cauliflower. The information on the biology and life table parameters of *M. persicae* obtained in the present study were of much practical significance in pest management strategies and the results provide a basis for the future study in determining the factors regulating populations in the field.

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