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RESEARCH ARTICLE :

Life fecunity table of *Leucinodes orbanalis* Guenee on brinjal in laboratory condition

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SUMMARY : Laboratory experiment was conducted during *Kharif* 2009 and 2010 at Department of Entomology, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani (Maharashtra) to study Life fecundity table of *Leucinodes orbonalis Guenee* on Brinjal under laboratory condition.In life table studies egg to adult emergence, 5 per cent male and 6 per cent female moths emerged successfully. The net reproductive rate (R_0) representing the total females per female per generation was 17.01. The finite rate of increase in number (λ) was 1.21 females per female per day. The corrected value of the intrinsic rate (r_m) was 0.0833 female per female per day. On reaching stable age-distribution the population of *L. orbonalis* in its various stages v*iz.*, egg, larva, pre-pupa, pupa and adult was distributed to the extent of 52.72, 38.83, 3.72, 4.34 and 0.38 per cent, respectively.

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KEY WORDS :
Biology, Egg, Larva, Pupa, Laboratory

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BACKGROUND AND OBJECTIVES

Brinjal or Baingan (*Solanum melongena* Linnaeus) known as egg plant and aubergine in North America and Europe, respectively, is an important vegetable in India. It is native of India and locally called 'Wangi' in Maharashtra often described as poor man's vegetable. After potato, it ranks second highest consumed vegetable in India, along with tomato and onion.Brinjal is a good source of carbohydrates, proteins, vitamin A, B, C and minerals like iron, phosphorus and calcium. It has medicinal properties also (Choudhari, 1967). Though perennial vegetable, it is grown as a seasonal crop throughout the country. The crop suffers due to whitefly (*Bemisia tabaci* Gennadius), aphid (*Aphis gossypii* Glover), jassid (*Amrasca biguttulabiguttula* Ishida), thrips (*Thrips tabaci* Lindemann), epilachna beetle (*Henosepilachna viginitioctopunctata* Fabrcius), mites (*Intranychus macfuslanii* Baker and Pricthaid) and shoot and fruit borer (*Leucinodes orbonalis* Guenee). Of these brinjal shoot and fruit borer, *L. orbonalis* is serious throughout the country. Damage of the borer starts in nursery before transplanting and continues upto harvest. It infests young shoots which limits the ability of plants to produce healthy fruit bearing shoots thereby reducing potential yield. It bores into fruits making them unmarketable. Infested fruits often show holes plugged with excreta. The

shoot and fruit damage may reach 70 per cent (Lal,1964). Damaged fruits show 68 per cent reduction in ascorbic acid (Hami, 1995). Overall losses due to insect pests vary from 26.3 to 65.5 per cent (Gangwar and Sachan, 1981) with a maximum of 95.8 per cent (Akhtar and Khawja, 1973). Life tables determine population growth characters of insect pests. They provide rate of multiplication of pest species under given set of climatic conditions which forms sound ecological base for pest management practices.

RESOURCES AND METHODS

Rearing of insect :

The laboratory culture of *L. orbonalis* was initiated by collecting infested fruits of brinjal from field.The larvae were reared individually in 5 x 5 cm plastic containers by providing them with fresh pieces of brinjal fruits daily in morning, until pupation.The newly emerged male and female moths were placed in oviposition cage (plastic jars of 19 cm height and 21 cm diameter). The tender brinjal twigs with succulent leaves were placed in small conical flask containing water which served as a substrate for oviposition.The cotton swabs dipped in five per cent honey were placed in petridish at the bottom of cage to serve as food for emerging moths. The cage was covered with muslin. The freshly laid eggs thus obtained were used for laboratory investigations. The culture was maintained at ambient room temperature conditions.

Life fecundity tables of *L. orbonalis* on brinjal :

The life fecundity tables of *L. orbonalis* on brinjal were constructed by studying 100 eggs in a group of 20 each. The eggs on white paper were moistened in petriplates to facilitate hatching. All the larvae soon after hatching were reared individually on small pieces of brinjal fruits daily. Everyday observations on hatching, larval and pupal development, successful adult emergence, fecundity and age specific mortality in eggs, larvae, pupae and adults were taken. Adults emerged on same day were transferred to a separate cage for determining age-specific fecundity. As per Southwood (1968), female births (m_x) were calculated by dividing eggs laid per female, considering the sex ratio 1:1.The life fecundity tables under laboratory conditions were constructed by using the following column headings proposed by Birch (1948), elaborated by Howe (1953) and Atwal and Bains (1974).

x = Pivotal age in days
l_x = Survival of females at age x
m_x = Age schedule for female birth age 'x'

Net reproductive rate (R_0) :

The sum of products '$l_x m_x$' is the net reproductive rate represented by R_0 (Lotka, 1925). The net reproductive rate is the rate of multiplication of the population in each generation measured in terms of females produced per generation. The number of times a population would multiply per generation was calculated by the following formula,

$$R_0 = \Sigma\, l_x m_x$$

Mean generation time (T_C) :

The precise value of cohort generation time (The mean age of the mothers in a cohort at the birth of female off spring) was calculated as under

$$T_c = \frac{\Sigma l_x m_x}{R_o}$$

Innate capacity for increase in numbers :

The number of individuals survived and the mean number of female offsprings produced at each age interval was recorded. From the data of life-tables, the arbitrary value of innate capacity for increase r_c was calculated as per Laughlin (1965).

$$r_c = \frac{\text{Log } R_0}{T_c}$$

The intrinsic rate of natural increase (r_m) was then calculated from the value of arbitrary 'r_m' by taking two trial values arbitrarily selected on either side of it, differing in the second decimal place by interpolation with the formula given by Birch (1948) and Watson (1964).

$$p\ e^{7\text{-}rm\ x\ lxmx} = 1096.6$$

Table was then constructed with column 'x' and $l_x m_x$' for each trial 'r_m'. The two trial values of $\Sigma\, e^{7\text{-}r_m{}^x} l_x m_x$ were then plotted on the horizontal axis against their, respective arbitrary 'r_m's on the vertical axis. The points were joined to give a line which intersected a vertical line drawn from the desired values of $\Sigma\, e^{7\text{-}r_m{}^x} l_x\ m_x$ = 1096.6. The point of intersection gave the value of true 'r_m' accurate to four decimal places. The precise generation time (T) was then calculated from the formula

$$T = \frac{\text{Log}_e R_0}{r_m}$$

The finite rate of natural increase (^{a}) :

The finite rate of natural increase (λ) *i.e.* females per female per day was calculated as under

$$^a = \text{anti log}_e\ r_m$$

Stable-age-distribution :

The stable age distribution (% distribution of various age groups) is the distribution, which would be reached by a population of stable age schedule of birth rate and death rate (m_x and l_x) when grown in a limited space (Andrewartha and Birch, 1954). The stable age distribution was worked out with knowledge of r_m and age specific morality of the immature as well as mature stages.

$$l_x = \frac{l_x + (l_x + 1)}{2}$$

The lx was multiplied with $e^{7-rm(x+1)}$ and the percentage distribution of each pivotal age (x) was worked out. By putting together the percentages under each pivotal age for respective stages *viz.*, egg, larva, pupa and adult, the expected percentage distribution of each stage in a stable age distribution was calculated.

OBSERVATIONS AND ANALYSIS

The results obtained from the present study as well as discussions have been summarized under following heads:

Life-fecundity tables of *L. orbonalis* on brinjal :

The life-fecundity tables of *L. orbonalis* were constructed for three generations during 2009-2010.The observations on hatching of eggs, larval, pupal and age-specific mortality of females and fecundity were taken.

Life-fecundity tables of *L. orbonalis* in first generation :

The results pertaining to life-tables and age-specific fecundity of *L. orbonalis* on brinjal obtained in first generation are presented in Table 1 to 5.

The data presented in Table 1 revealed that in a cohort of 100 eggs the survival of *L. orbonalis* on brinjal during first generation was found to be 81, 55, 50 and 50 per cent in egg, larval, pre-pupal and pupal stages, respectively. During egg to adult emergence 5 per cent male and 6 per cent female moths emerged successfully.

The data obtained on life-table and age-specific fecundity of *L. orbonalis* during first generation are tabulated in Table 2 revealed that the survival of immature stage (l_x) was 0.11 per individual within a pivotal age of

Table 1 : Survival of life stages of *L. orbonalis* during development in first generation

No. of eggs observed	Numbers surviving					
	Incubation period (0-5 days)	Larval period (6-17 days)	Pre pupal period (18-20days)	Pupal period (21-31 days)	Adult	
					Male	Female
20	18	10	10	10	1	2
20	13	8	8	8	1	1
20	16	13	10	10	1	1
20	17	11	11	11	--	2
20	17	13	11	11	2	--
100	81	55	50	50	5	6

Table 2 : Life table and age specific fecundity of *L. orbonalis* in first generation

Pivotal age in days	Survival of females of different age intervals		Age schedule for female birth	
X	l_x	m_x	l_xm_x	l_xm_xX
0-31	0.11		Immature stages	
32	0.11		Pre oviposition period	
33	0.11			
34	0.11	46.42	5.11	173.74
35	0.10	82.90	8.29	290.15
36	0.08	45.17	3.61	129.96
37	0.05	0.00	0.00	0.00
			$\Sigma 1_xm_x (R_0) = 17.01$	$\Sigma\ 1_xm_xX = 593.85$

31 days on brinjal. The pre-oviposition period varied from 32nd to 33rd day of pivotal age. The number of eggs laid per female was divided by two to get the number of female births (m_x). The female births were highest (82.90) on 2nd day of oviposition period at 35th day of pivotal age. The first female mortality was recorded on 35th day of pivotal age. The net reproductive rate (R_0) representing the total females per female per generation was 17.01. Thus the population of *L. orbonalis* was able to multiply 17.01 times per generation on brinjal.

The data pertaining to length of generation, intrinsic rate of increase in numbers and finite rate of increase in numbers (ë) observed on *L. orbonalis* is presented in Table 3.

It is evident that the mean length of generation (T_c) and the arbitrary value for innate capacity for increase in number (r_c) were 34.91 days and 0.081 female per female per day. The corrected value for intrinsic rate of natural increase (r_m) and precise generation time (T) were 0.083 female per female per day and 34.04 days. The finite rate of increase in number (λ) was 1.21 females per female per day.

The data for calculation of corrected value of intrinsic rate of increase in numbers (r_m) are presented inTable 4. Three trial values of arbitrary intrinsic rate 'r_m' *i.e.* 0.08, 0.09 and 0.10 were selected in ascending order. Three trial values of 1144.20, 807.36 and 569.71 were plotted on horizontal axis against their respective arbitrary intrinsic rate 'r_m' on vertical axis. The points obtained were joined to get a line which intersected a vertical line drawn from the desired value of equation *i.e.* $\Sigma e^{7-rmx} l_x m_x = 1096.6$ (Birch, 1948 and Watson, 1964). The point of intersection gave the corrected value of the intrinsic rate (r_m) of 0.0833 female per female per day.

The contribution of different developmental stages towards the stable age-distribution of *L. orbonalis* was worked out and the data are presented in Table 5.

On reaching stable age-distribution the population of *L. orbonalis* in its various stages *viz.*, egg, larva, pre-pupa, pupa and adult was distributed to the extent of 52.72, 38.83, 3.72, 4.34 and 0.38 per cent, respectively.

According to Satpathi *et al.* (2006) the net fecundity rate (R_O) was higher in summer (9.42) than in winter (5.05). Similar trends of the net reproductively rate (r_m)

Table 3 : Mean length of generation, innate capacity for increase in numbers and finite rate of increase in number observed on *L. orbonalis* during first generation

Population growth statistics	
Mean length of generation	
$T_c = \frac{l_x m_x X}{R_o}$	34.91 days
Innate capacity for increase in number	
$r_c = \frac{\text{Log}_e R_o}{T_c}$	0.081 female/female/day
Arbitrary r_m (r_c), 0.08, 0.09, 0.10	
Corrected r_m, $\Sigma e^{7-rm \times lxmx} = 1096.63$	0.0833 female/female/day
Corrected generation time	
$T = \frac{\text{Log}_e R_o}{r_m}$	34.04 days
Finite rate of increase in number (λ)	
$\lambda = \text{antilog}_e r_m$	1.211 females/female/day

Table 4 : Calculation of r_m of *L. orbonalis* by trial and error method in first generation

Pivotal age	$l_x m_x$	r_m=0.08		r_m=0.09		r_m=0.10	
		$e^{(7-rmx)}$	$e^{(7-rm \times l_x m_x)}$	$e^{(7-rmx)}$	$e^{(7-rm \times l_x m_x)}$	$e^{(7-rmx)}$	$e^{(7-rm \times l_x m_x)}$
32-33	--	--	--	--	--	--	--
34	5.11	72.24	369.15	51.42	262.75	36.60	187.02
35	8.29	66.69	552.83	46.99	389.57	33.12	274.52
36	3.61	61.56	222.23	42.95	155.04	29.96	108.17
37	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total			1144.20		807.36		569.71

and intrinsic rate of increase ($r_{m)}$ were 18.89 and 0.1059 in summer and 10.31 and 0.05222 in winter, respectively. The finite rate of increase (λ) was unaffected but the mean generation time (T) abruptly increased in the winter (31.023 days) than summer season (21-179). The insect was able to multiply 2.10 times per week in summer and 1.44 times in winter but the doubling time of population occurred in one and two weeks during summer and winter, respectively.Similar results were recorded by Singh and Singh (2003), Jat *et al*. (2003) and Bodkhe (2004).

Table 5 : Stable age distribution of *L. orbonalis* in first generation

Age group in days (x)	Survival of individuals at different age interval (l_x)	Stable age distribution $L_x = l_x+(1x+1)$ / 2	$e^{7-rm(x+1)}$	Lx-$e^{7-rm(x+1)}$	Per cent age distribution	
0	1	0.99	0.9200	0.9108	11.8456	
1	0.97	0.94	0.8465	0.7951	10.3408	
2	0.91	0.89	0.7788	0.6931	9.0142	52.72 Egg
3	0.87	0.86	0.7166	0.6162	8.0141	
4	0.85	0.83	0.6593	0.5472	7.1167	
5	0.81	0.81	0.6066	0.4913	6.3897	
6	0.81	0.80	0.5581	0.4464	5.8057	
7	0.79	0.77	0.5135	0.3953	5.1411	
8	0.75	0.74	0.4725	0.3496	4.5468	
9	0.72	0.70	0.4347	0.3042	3.9563	
10	0.68	0.68	0.3999	0.2719	3.5362	
11	0.67	0.66	0.3680	0.2428	3.1577	38.83 Larva
12	0.65	0.63	0.3386	0.2133	2.7741	
13	0.61	0.60	0.3115	0.1869	2.4307	
14	0.58	0.58	0.2866	0.1662	2.1615	
15	0.58	0.57	0.2637	0.1503	1.9547	
16	0.56	0.56	0.2426	0.1358	1.7661	
17	0.55	0.55	0.2232	0.1227	1.5958	
18	0.54	0.52	0.2054	0.1068	1.3890	
19	0.52	0.51	0.1890	0.0963	1.2524	3.72 Pre pupa
20	0.50	0.48	0.1738	0.0834	1.0846	
21	0.45	0.43	0.1599	0.0687	0.8934	
22	0.40	0.38	0.1472	0.0559	0.7229	
23	0.36	0.35	0.1354	0.0473	0.6151	
24	0.33	0.31	0.1246	0.0386	0.5020	
25	0.29	0.27	0.1146	0.0309	0.4018	
26	0.25	0.24	0.1054	0.0252	0.3277	
27	0.22	0.21	0.0970	0.0203	0.2640	4.34 Pupa
28	0.20	0.19	0.0893	0.0169	0.2197	
29	0.17	0.16	0.0821	0.0131	0.1703	
30	0.14	0.13	0.0755	0.0098	0.1274	
31	0.13	0.11	0.0695	0.0076	0.0988	
32	0.11	0.11	0.0639	0.0070	0.0910	
33	0.11	0.11	0.0588	0.0064	0.0832	
34	0.11	0.11	0.0541	0.0059	0.0767	0.38 Adult
35	0.10	0.09	0.0498	0.0044	0.0572	
36	0.08	0.07	0.0458	0.0032	0.0416	
37	0.05	0.05	0.0421	0.0021	0.0273	

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