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Age-specific ecological life table of *Spodoptera litura* (F.) (Lepidoptera, Noctuidae) on groundnut

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ABSTRACT: Experiments were conducted to study the life history traits of *Spodoptera litura* under controlled environmental conditions on groundnut host. To construct the age-specific fecundity life tables, adults emerged on the same day were caged for oviposition and the number of eggs laid on each day was recorded. The key mortality factors involved in each life stages were also accounted. Females contributed highest number of progeny (m_x = 346.12) on 39th day of pivotal age. The net reproductive potential (R_o) was 858.52 females/female/generation with the mean generation period (T_c) of 38.86 days. The life table analysis revealed that the late instar larvae were more vulnerable to natural mortality factors (64.95%) and total mortality per cent recorded was 83.02. The various key mortality factors *viz*., parasitoids (*Cotesia* sp., *Chelonus* sp. and Tachinids), virus (NPV), malformed pupa and adults were recorded from the field population of *S. litura* from groundnut ecosystem.

KEY WORDS: Vital statistics, net reproductive rate, intrinsic rate of increase, mortality factors

INTRODUCTION

Groundnut (*Arachis hypogaea* L.) is an annual, herbaceous legume and important oil seed crop. Tobacco caterpillar, *Spodoptera litura* (Fab.) is one of the important pests, infesting more than 290 species of plants belonging to 99 families (Wu *et al.,* 2004). Among the various insect pests attacking groundnut, leaf eating caterpillar, *S. litura* commonly known as tobacco caterpillar, causes extensive damage and it is found to be serious pest on groundnut (War *et al*., 2011). The frequent outbreaks of *S. litura* occurs mainly due to insecticide resistance and favourable environmental conditions (Rao *et al*., 2020). Hence, it is important to study the vital statistics and ecological parameters that influence *S. litura* population in groundnut ecosystem.

Understanding the most vulnerable stage in the biology of an insect is the key to its management, most such weaknesses in the insect life cycle can be best understood by studying its life-tables (Deevey, 1947). To know the comprehensive description of the key mortality factors, survivorship, development and expectation of life, life table is an important analytical tool, which provides detailed information of population dynamics (Southwood

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1978). Life table studies provide an opportunity to assess and evaluate the impact of specific mortality factors acting on insect population (Carey 1993). Through life table studies, age-specific mortality factors and survival rates of a pest species can be determined (Birch, 1948). Life-tables constructed using laboratory data collected under controlled conditions are useful in revealing the maximal growth potential of a population (Ashok *et al*., 2020). The construction of several life tables might be used to prepare a predictive model which can be tested against natural population fluctuations. In this view, the present study was conducted to determine age specific survivals, fecundity and different population growth statistics and ecological mortality factors of *S. litura* on groundnut.

MATERIALS AND METHODS

Age-specific life table analysis of *S. litura*

To construct age-specific life and fertility tables, 10 pairs of newly emerged adults of laboratory reared population were enclosed for oviposition in wooden cages of size 45×45×60 cm. Potted groundnut plants were provided for oviposition along with cotton swab dipped in 10 per cent honey solution to serve as food for the adults. After oviposition, batch of 100 eggs were collected and placed in ten plastic containers in ten batches of each. Immediately after hatching, the larvae were transferred individually to plastic containers with fresh leaves of groundnut (replaced daily until pupation) and reared to record age-specific mortality in different developmental stages. To construct age-specific fecundity life tables, adults emerged on the same day were caged for oviposition and the number of eggs laid on each day was recorded. The observation on fecundity was continued until all the females died. As the sex ratio will be 1:1, the number of eggs obtained per female was divided by two to get the number of female birth. The following parameters of age-specific life tables were worked out (Howe, 1953):

X = pivotal age in days
L_x = survival of female at age 'x'
m_x = age schedule for female births at age 'x'
R_o = net reproductive rate
r_m = innate capacity for increase in number
T_c = mean duration of generation

Net reproductive rate (Ro)

The 'Ro' is the rate of multiplication of population in generation measured in terms of females produced per generation. The sum total of the products 'lx.mx' is the net reproductive rate (Ro).

$$R_o = \sum l_x . m_x$$

Mean duration of generation (Tc)

The mean age of the mothers in a cohort at the birth of female offspring.

$$T_c = \frac{\sum x.lx.mx}{Ro}$$

Innate capacity of increase in number (r_m)

Total number of individuals survived and mean number of female offspring births were recorded at each age interval. From these data, the arbitrarily value of 'rm' was derived by the following formula:

$$r_m = \frac{\log_e Ro}{Tc}$$

Where, e = 2.71828, Tc = Mean generation time

The intrinsic rate of increase (rm) was subsequently calculated from the arbitory 'rm' by taking two trial values selected on either side of it differing in the second decimal places by establishing the relationship (Atwal and Bains, 1974).

$$e^{7-rmx.lxmx} = e^{7} = 1097$$

The values of obtained from the two trials were plotted against their respective arbitory 'rm' which give a straight line. The straight line was intersected by a vertical line drawn from the described values of =1097. The points of intersection gave the value of true 'rm' accurate to four decimal points.

The finite rate of natural increase (λ)

The number of females per female per day *i.e.,* finite rate of increase was determined as:

λ = antilog e^{rm}

From this data, the weekly multiplication of the population was calculated. The hypothetical F_2 females were also worked out with the formula $(Ro)^2$.

Age-specific distribution

Age-specific distribution (per cent distribution of various age groups) of *S. litura* on groundnut was worked out with the knowledge of 'rm'. The stable age distribution was constructed by following the method of Andrewartha and Birch (1954). The 'Lx' (Life table age distribution) was calculated from the 'lx' table by using the following formula:

$$Lx = \frac{lx + (lx + 1)}{2}$$

Per cent distribution of each age group (x) was calculated by multiplying the Lx with . By putting together, the percentage under each stage *viz*., egg, larval, pupal and adult stages, the expected per cent distribution was worked out.

Life expectancy of *S. litura*

Life expectancy of the pest was worked out by using columns x, l_x, d_x, $100q_x$, L_x, T_x and e_x.

Where, x = Pivotal age (days), lx = Number of surviving at the beginning of age interval out of 100, dx = Number dying during 'x', T_x = Number of individual's life days beyond 'x', Mortality rate per hundred alive at the beginning of age interval, Alive between x and x + 1; X_2= Expectation of further life

Ecological life table analysis of *S. litura*

To study the various key mortality factors of *S. litura* in the groundnut ecosystem, sampling of different life stages *viz*., eggs, larvae, pupae was done. The egg masses were collected and recorded the mortality of eggs either due to infertility, parasitization or unknown causes. Similarly, different larval stages were collected at weekly interval and reared in the laboratory in plastic boxes to record the mortality in each instar either due to parasitization, disease or due to unknown causes. The absolute population of egg, larvae per ten quadrates (each quadrate measuring 4x4.2m) was recorded in the field throughout the cropping season. To study the mortality factors in the pupal stage, ten random spots were dug in the cropped area to calculate the pupal population. The number of malformed pupae, infected pupae and incompletely pupated ones were counted and the percentage of the same was calculated, besides per cent adult emergence was also computed. As different developmental stages of *S. litura* were collected at weekly interval, the developmental stages were reared till the adult emergence and the different mortality factors at each stage was recorded. The natural enemies collected during the study were identified at ICAR-National Bureau of Agricultural Insect Resources (NBAIR), Bengaluru, Karnataka, India.

Survivorship curve and mortality of *S. litura*

The survivorship curves were drawn by plotting the number living at a given age (lx) against the age (x). The shape of the curve will describe the distribution of mortality with age (Slobodkin, 1962). Different mortality factors were identified and corresponding K-values were assigned for each mortality factors at different developmental stages and the relationship between mortality of *S. litura* and K-values was worked out. the following parameters proposed by Morris and Miller (1954) were accounted.

x = Stage or age interval at which the sample was taken

l_x = The number surviving at the beginning of the stage stated in the x-column

d_x = The number dying within the age interval stated in the x-column

d_xf = The mortality factors responsible for d_x

$100q_x$ = Percentage mortality (dx as percentage of l_x)

S_x = Survival rate within the stage mentioned in the x column

RESULTS AND DISCUSSION

Survival of different life stages of *S. litura*

The maximum duration of different developmental stages of *S. litura* on groundnut *i.e.,* eggs, larvae and pupae were 3, 17 and 10 days, respectively.

day of pivotal age (l_x=0.76) and mortality increased slowly, indicated by a gradual decrease in the l_x values (Table 2). Females contributed maximum mean progeny production per day (m_x=346.12) on the 39th day of pivotal age which declined (m_x=62.00) on 42nd day (Fig. 1). Age-specific fecundity indicated slow raise in the fecundity at initial stages and it gradually raised to reach the peak followed by gradual decrease in the fecundity. Pre-oviposition period of *S. litura* on tobacco ranged from 36th to 37th days of pivotal age and females contributed highest number of progeny (m_x=508.92) on the 41st day of pivotal age (Patil *et al*., 2014).

Life history parameters of *S. litura*

The net reproductive rate (R_o) was 858.52. The data on mean length of generation time (T_c) was 38.86 days. The intrinsic rate of natural increase in number (r_m) was 0.1738 females per female per day with a daily finite rate of increase in number (ë) 1.19 females per female per day and population of *S. litura* would be able to multiply 3.38 times per week under the given set of conditions. The hypothetical female's population in F_2 generation was found to be 733056.60 and the potential fecundity was 1215.49 eggs per female (Table 3). The intrinsic rate of natural increase (r_m) of the population on different host plants ranged from 0.153 to 0.195 females /female/day (Sooravan *et al.,* 2005). Intrinsic rate of laboratory reared *S. litura* on peanuts was 0.1828 females /female/day (Tuan *et al.,* 2013). According to Sundaram *et al.* (2006) the population doubling time of *S. litura* on cauliflower leaves was 3.85 days.

Age-specific distribution of *S. litura* on groundnut

The investigation on the contribution of each developmental stage of *S. litura* on groundnut towards the stable age distribution was calculated by observing the age schedule of birth rate and death rate (m_x and l_x). Adults contributed only 0.20 per cent to the population of stable age, whereas eggs, larvae and pupae contributed 52.46, 45.71 and 1.60 per cent, respectively (Table 4). This indicates that immature stages contributed highest to the stable age distribution of the population. The contribution of eggs, larvae, pupae and adults of *S. litura* were 52.0, 46.4, 1.3 and 0.3 per cent, respectively on groundnut (Gedia *et al*., 2008).

Life expectancy of *S. litura*

The life expectancy (e_x) of *S. litura* declined gradually with the advancement of age. Life expectancy of newly deposited eggs was 13.30 days. The mortality rate (d_x) increased gradually which is indicated by a decrease in the l_x values

Table 1. Survival of different developmental stages of *S. litura* on groundnut

Replications	No. of eggs	Egg hatched (0 to 3 days)	Larval survival (4 to 21days)	Pupal survival (22 to 32 days)
1	10	8	7	6
2	10	10	10	9
3	10	10	8	8
4	10	10	10	9
5	10	7	6	6
6	10	10	8	8
7	10	10	10	9
8	10	8	7	7
9	10	10	9	8
10	10	9	8	8
Cumulative mortality (%)	-	8	17	22

Table 2. Age-specific fecundity of *S. litura* on groundnut

x	l_x	m_x	$l_x m_x$	$xl_x m_x$
0-32	0.78	-	-	Immature
33	0.78	-	0.78	25.74
34	0.78	-	0.78	26.52
35	0.78	-	0.78	27.30
36	0.78	48.75	38.02	1368.72
37	0.78	131.75	102.76	3802.12
38	0.78	231.37	180.46	6854.82
39	0.76	346.12	263.05	10258.95
40	0.67	256.75	172.02	6880.80
41	0.55	138.75	76.31	3128.71
42	0.38	62.00	23.56	989.52
43	0.23	0.00	0.00	0.00
			$Ro=\sum l_x m_x=858.52$	$\sum xl_x m_x=33363.20$

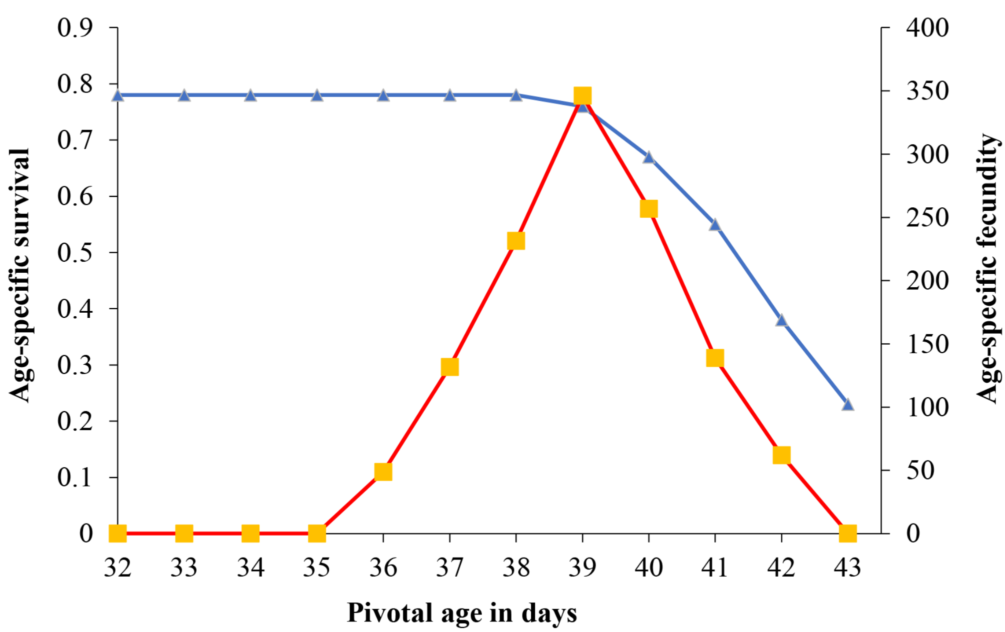

Fig. 1 Age-specific survival and fecundity of *S. litura* on groundnut

Out of 100 eggs 92 eggs hatched successfully into larva, 83 larvae successfully pupated out of 92 larvae and total of 78 adults successfully emerged (Table 1). The cumulative mortality during egg, larval and pupal stages was 8, 17 and 22 per cent respectively. Egg, larva and pupa of *S. litura* on tobacco was having duration of 4, 18 and 13 days, respectively (Patil *et al.,* 2014).

Age-specific fecundity of *S. litura*

Pre-oviposition period of *S. litura* ranged from 33rd to 35th day of pivotal age. Females deposited the first batch of eggs on the 36th day (m_x=48.75) and continued up to 42nd day (m_x=62.00) with l_x values being 0.78 and 0.38 respectively. The first female mortality was observed on the 7th day *i.e.,* on 39th

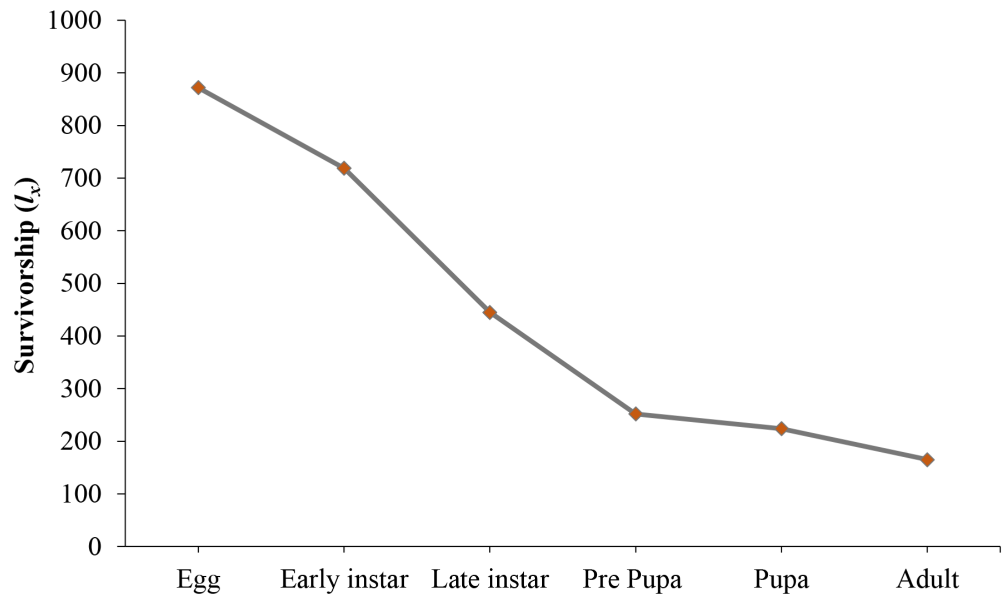

Fig. 2 Survivorship curve of *S. litura* on groundnut

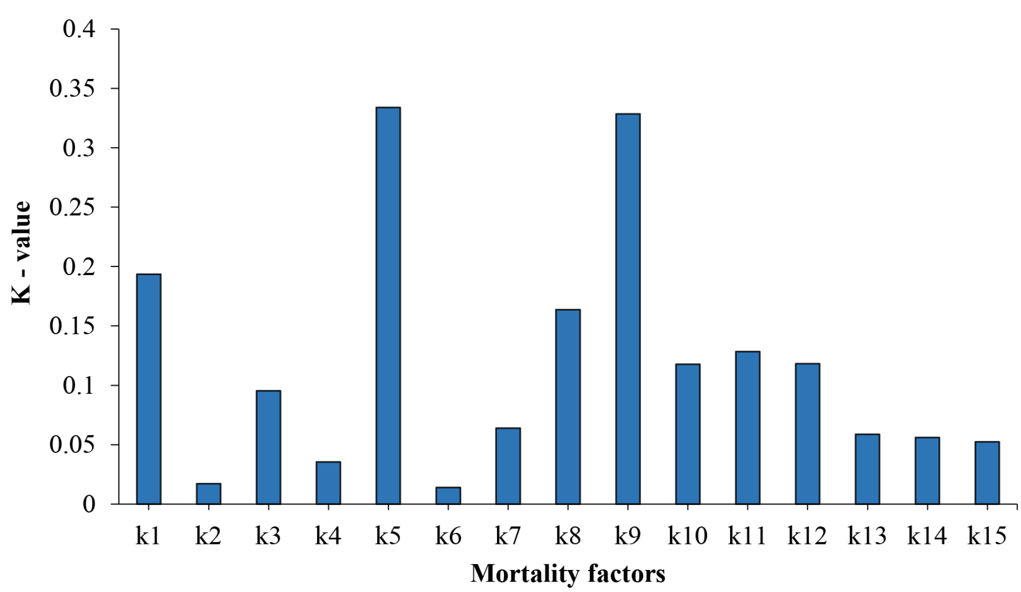

Fig. 3 Key mortality factors of *S. litura* in groundnut ecosystem

and mortality was comparatively high at 35th to 40th day of pivotal age (Table 5), which is indicated by the reduction in the life expectancy to 1.00 day from 13.30 days in the beginning. Life expectancy of *S. litura* eggs was 17.34, 17.44, 16.39, 17.45 and 17.98 on castor, tobacco, groundnut, cotton and cabbage, respectively (Maghodia and Koshiya, 2008). The expected further life of *S. litura* at the age of 15 to 20 days was reduced to 7.08 from 12.82 days (Dhabi *et al*., 2009).

Ecological life table analysis of *S. litura*

Ecological life table was constructed for the field population to understand the role of various key mortality factors that influence the population of *S. litura* in groundnut ecosystem during Kharif, 2017. The total mortality of *S. litura* was 83.02 per cent. The highest mortality was observed in the larval stage (64.95%); followed by pupal stage (26.33%), egg stage (17.54%) and adult stage (10.30%). The egg mortality in *S. litura* was mainly due to unknown causes (17.54%). In the early instar larvae, the total mortality was 42.47 per cent, of which unknown causes alone contributed to 28.34 per cent mortality, followed by tachinids parasitization upto 9.05 per cent. NPV accounted for mortality of 3.42 per cent and *Cotesia* sp. accounted for low mortality *i.e.,* 1.66 per cent. The number of early instar larvae that survived at the end were 445 (Table 6).

In case of late instar larvae, the total mortality recorded was 50.53 per cent, unknown causes alone contributed to 28.00 per cent mortality, whereas, tachinid parasitoids, *Peribaea orbata*, *Carcelia* sp.*,* *Chelonus* sp. and NPV accounted for 6.15, 1.34 and 15.04 per cent mortality, respectively (Table 6). The number of late instar larvae that survived at the end was 252. Larval parasitoids, *Perbaea orbata* (Wiedemann) and *Apanteles ruficrus* (Haliday) caused 13.7 and 8.2 per cent mortality, respectively in *S. litura* on groundnut (Sridhar and Prasad, 1996). In the first generation the early instars larval mortality was 5.7 per cent and the late instar larval mortality was due to unidentified parasitoid and unknown reasons, 6.05 and 3.24 per cent mortality, respectively. In the second generation, mortality of early instar larvae due to unknown reason was 9.1 per cent and mortality in late instar larvae due to unknown reason was 25.0 per cent (Jadhav *et al.*, 2006). Key mortality factors like *Apanteles* spp., green muscardine fungus and an unidentified tachinid fly were the major mortality factors of *S. litura* infesting cabbage during the rainy season and *C. chloridae* during the winter season (Patait *et al.*, 2009).

Table 3. Life history traits of *S. litura* on groundnut

Population growth statistics	Formula	Calculated value
Net reproductive rate (R_o)	$\sum l_x m_x$	858.52
Mean length of generation (T_c)	$\sum x l_x m_x / R_o$	38.86 days
Innate capacity for increase in number (r_m)	$Log_e R_o / T_c$	0.1738 females/female/day
Finite rate of increase in Number (λ)	antilog e^{rm}	1.19 females/female/day
Arbitary 'r_m' (r_c)	-	0.18
Weekly multiplication of population	(λ) w	3.38
Doubling time (DT)	$\log 2/r_m$	3.98 days
Potential fecundity (Pf)	$\sum m_x$	1215.49
Hypothetical F_2 females	$(R_0)^2$	737056.59

Table 4 Age-specific distribution of *S. litura* on groundnut

x	l_x	X+1	r_m*(x+1)	exp(r_m*x+1)	Lx(exp(r_m*x+1)	% contribution	
0	1	1	-0.1738	0.8404	0.8404	16.7068	Egg 52.46
1	1	2	-0.3476	0.7063	0.7063	14.0415	
2	1	3	-0.5214	0.5936	0.5936	11.8013	
3	1	4	-0.6952	0.4989	0.4989	9.9186	
4	1	5	-0.8690	0.4193	0.4193	8.3362	Larvae 45.71
5	0.92	6	-1.0428	0.3524	0.3242	6.4458	
6	0.92	7	-1.2166	0.2962	0.2725	5.4175	
7	0.91	8	-1.3904	0.2489	0.2265	4.5037	
8	0.91	9	-1.5642	0.2092	0.1904	3.7852	
9	0.91	10	-1.7380	0.1758	0.1600	3.1813	
10	0.90	11	-1.9118	0.1478	0.1330	2.6444	
11	0.90	12	-2.0856	0.1242	0.1118	2.2225	
12	0.87	13	-2.2594	0.1044	0.0908	1.8057	
13	0.87	14	-2.4332	0.0877	0.0763	1.5176	
14	0.86	15	-2.6070	0.0737	0.0634	1.2608	
15	0.85	16	-2.7808	0.0619	0.0526	1.0473	
16	0.85	17	-2.9546	0.0520	0.0442	0.8802	
17	0.85	18	-3.1284	0.0437	0.0372	0.7398	
18	0.84	19	-3.3022	0.0368	0.0309	0.6145	
19	0.84	20	-3.4760	0.0309	0.0259	0.5164	
20	0.84	21	-3.6498	0.0259	0.0218	0.4340	
21	0.84	22	-3.8236	0.0218	0.0183	0.3648	
22	0.83	23	-3.9974	0.0183	0.0152	0.3029	Pupae 1.60
23	0.83	24	-4.1712	0.0154	0.0128	0.2546	
24	0.83	25	-4.3450	0.0129	0.0107	0.2140	
25	0.83	26	-4.5188	0.0109	0.0090	0.1798	
26	0.83	27	-4.6926	0.0091	0.0076	0.1511	
27	0.83	28	-4.8664	0.0077	0.0063	0.1270	
28	0.81	29	-5.0402	0.0064	0.0052	0.1042	
29	0.81	30	-5.2140	0.0054	0.0044	0.0875	
30	0.80	31	-5.3878	0.0045	0.0036	0.0727	
31	0.80	32	-5.5616	0.0038	0.0030	0.0611	
32	0.78	33	-5.7354	0.0032	0.0025	0.0500	
33	0.78	34	-5.9092	0.0027	0.0021	0.0420	Adult 0.20
34	0.78	35	-6.0830	0.0022	0.0017	0.0353	
35	0.78	36	-6.2568	0.0019	0.0014	0.0297	
36	0.78	37	-6.4306	0.0016	0.0012	0.0249	
37	0.78	38	-6.6044	0.0013	0.0010	0.0210	
38	0.78	39	-6.7782	0.0011	0.0008	0.0176	
39	0.76	40	-6.9520	0.0009	0.0007	0.0144	
40	0.67	41	-7.1258	0.0008	0.0005	0.0107	
41	0.55	42	-7.2996	0.0006	0.0003	0.0073	
42	0.38	43	-7.4734	0.0005	0.0002	0.0042	
				Total	5.0306	100.00	100.00

In the pre-pupal stage, the unknown causes were noted to be the major mortality factor (11.11 %). The population at the beginning of pupal stage was 224. Pupal mortality due to malformation, non emergence of adult from pupae and unknown causes during the pupal stage were 12.05, 11.16 and 5.71 per cent, respectively. In the adult stage, 5.45 and 5.12 per cent mortality due to adult malformation and unknown causes in moths was observed. The malformed moths with twisted wing were incapable of reproduction and the final population that survived was 148 (Table 6). Pupal mortality due to unknown reasons was 20.0 per cent (Jadhav *et al.*, 2006). The key mortality factors of *S. litura* on groundnut were NPV, parasites like *Cotesia* spp. and tachinid maggot (Kumar *et al.*, 2015).

The generation survival of 0.1697 indicated that only 16.97 per cent of the initial population could survive and successfully complete the generation. The number of larvae dead due to unknown causes contributed maximum to high 'K' value of 0.6625, followed by NPV infection, tachinids and *Cotesia* sp. with 'K' values of 0.1992, 0.1594 and 0.0171, respectively (Table 6). The remaining minor mortality factors like *Chelonus* sp. and malformed stages contributed less to 'K' value in the age-specific life table of *S. litura.*

Survivorship curves

The survivorship curve pattern of *S. litura* during *Kharif* 2017 plotted on a semi-logarithmic scale. It was observed that the curve obtained in the present study was almost similar to type III curves indicating that the mortality rate was constant in all the stages. Further, the drop in survivorship was glaringly high in the late instar larvae but the end result of all the curves suggested a steady drop in the survivorship of *S. litura* by the adult stage. This survivorship curve indicates that there was comparatively high mortality in early stages of development and the population *S. litura* stabilizes over the period of time as there is constant mortality and it showes distinct steps at each developmental stages (Fig. 2). So this indicates that intervention in the earlier stages of development can manage population of *S. litura*. Survivorship curves of 22 species of herbivores, out of these seven species (40%) belonged to convex type of survivorship curves. The rest, however, followed the intermediate forms between Type II and Type III curves for lepidopteran insects (Price, 1980). On five soya bean cultivars the survivorship curves of *S. exigua* was type III (Farhani *et al.,* 2011).

Table 5. Life expectancy of *S. litura* on groundnut

Pivotal age (Days) 'x'	Number Surviving to the beginning of the age interval	Number dying during 'x'	Mortality rate per hundred alive at beginning of the age interval $\frac{dx.100}{lx}$	Alive between age 'x' and 'x+1' $\frac{lx + (1x + 1)}{2}$	No. of the individuals life days beyond 'x'	Expectation of further life $\frac{Tx}{lx}$ x 2
(x)	(l_x)	(d_x)	(100 q_x)	(L_x)	(T_x)	(e_x)
0-5	100	8	8.00	96	665	13.30
5-10	92	2	2.17	91	569	12.36
10-15	90	5	5.55	87.50	478	10.62
15-20	85	1	1.17	84.50	390.5	9.18
20-25	84	1	1.19	83.50	306	7.28
25-30	83	3	3.61	81.50	222.5	5.36
30-35	80	2	2.50	79.00	141	3.52
35-40	78	55	70.51	50.50	62	1.58
40-45	23	16	69.56	11.50	11.50	1.00

Table 6. Ecological life-table of *S. litura* in groundnut ecosystem

Stages	No. alive at the beginning of x (l_x)	Factors responsible for dx (d_xF)	No.dead (a)	Mortality per cent $100q_x$	Mortality $d = a/l_x$	Survival S = 1-d	'K' value (-ln(s))
Egg (N1)	872	Unknown causes	153	17.54	0.1754	0.824	0.1935
Early instars	719	*Cotesia* sp.	12	1.66	0.0166	0.983	0.0171
	707	Tachinids	64	9.05	0.0905	0.909	0.0954
	643	NPV	22	3.42	0.0342	0.965	0.0356
	621	Unknown causes	176	28.34	0.2834	0.716	0.3340
Late instars	445	*Chelonus* sp.	6	1.34	0.0134	0.986	0.0140
	439	Tachinids	27	6.15	0.0615	0.938	0.0640
	412	NPV	62	15.04	0.1504	0.849	0.1636
	350	Unknown causes	98	28.00	0.2800	0.720	0.3285
Pre pupa	252	Unknown causes	28	11.11	0.1111	0.8889	0.1177
Pupa	224	Malformed pupae	27	12.05	0.1205	0.8795	0.1284
	197	Not emerged pupae	22	11.16	0.1116	0.8884	0.1183
	175	Unknown causes	10	5.71	0.0571	0.9429	0.0587
Adults	165	Malformed adult	9	5.45	0.0545	0.9455	0.0560
	156	Unknown causes	8	5.12	0.0512	0.9488	0.0525
Total			724	83.02			1.7773
Normal females x 2 (N2)			148				
Reproducing females x 2			74				
Generation survival (N2/N1)			0.1697				

Key mortality factors (K-factors)

A total of 15 mortality factors (K1 to K15) were identified in *S. litura* on groundnut during the study period. Larval parasitoids (*Cotesia* sp., *Chelonus* sp. and tachinids), virus (NPV), malformed pupa, adult malformation and unknown causes (Fig. 3). This indicates that there are good number of mortality factors operating in groundnut ecosystem in this area that can be utilised for management of *S. litura* on groundnut but the unknown causes dominated the K-values and the K-values of biotic factors *i.e.*, natural enemies contributed very less in the population reduction, this indicates that there is no sufficient population of natural enemies and efforts should be made to increase natural enemy population. In sunflower total of 14 mortality factors of *S. litura* were identified (Geetha and Jagadish, 2014).

Life-table provides an insight to assess and evaluate the impact of specific mortality factors acting on insect population. Various age-specific population growth statistics data like reproductive potential, age-specific fecundity, generation time and life expectancy of *S. litura* are useful in assessing population dynamics of the pest. Significant levels of mortality were found in different developmental stages of the pest and there are good number of key mortality factors especially tachinid parasitoids which are responsible for population reduction, these factors can be successfully employed in IPM to tackle population of *S. litura* in groundnut ecosystem.

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