International Journal of Advances in Life Science and Technology
2014 Vol.1, No.2, pp. 38-46
ISSN(e): 2313-8335
ISSN(p): 2412-3803
DOI: 10.18488/journal.72/2014.1.2/72.2.38.46

STUDIES ON LIFE FECUNDITY TABLES OF TOBACCO LEAF EATINGCATERPILLAR, *SPODOPTERA LITURA* (FABRICIUS) ON TOBACCO, *NICOTIANA TABACUM* (LINNAEUS)

R. A. Patil[1] --- D. M. Mehta[2] --- B. L. Jat[3] --- L. V. Ghetiya[4]

[1]*Deptt.of Entomology, B. A. College of Agriculture, Anand Agricultural University, Anand, Gujarat, India*

[2]*Principle Res. Scientist (Entomology) Bidi Tobacco Research Station, AAU, Anand, Gujarat, India*

[3]*Deptt.of Entomology, College of Agriculture, CCS Haryana Agricultural University, Hisar, Haryana, India*

[4]*Assoc. Prof. Deptt. of Entomology, NAU, Navsari, Gujarat, India*

ABSTRACT

Studies on Life tables of Spodoptera litura, were carried out on bidi tobacco cv ABD-101 under laboratory condition at 26 ± 1 °C temperature at Bidi Tobacco Research Station, Anand Agricultural University, Anand (Gujarat). The results on number of individuals survived during development revealed that there was no mortality during egg stage and the maximum durations of egg, larva and pupa were 4, 22 and 14 days, respectively. The number that survived from 100 eggs to adult emergence was 76. The pre-oviposition period was ranged from 41 to 42 days of pivotal age. Females contributed highest number of progeny (mx = 328.12) in the life cycle on the 45th day of pivotal age. The net reproductive potential (Ro) was 758.93 females with the mean length of generation period (T) of 45.67 days. The innate capacity for increase (rm) and finite rate of increase (λ) were found to be 0.1462 and 1.1574 females/ female/ day, respectively with a weekly multiplication rate $(\lambda)^7$ of 2.78 times. The hypothetical F_2 females were found to be 575974.70. Results on per cent contribution of different growth stages in stable age distribution revealed that the egg stage contributed was maximum (52.64%), while the contribution of larvae, pupae and adults were 45.86, 1.36 and 0.12, respectively at stable age distribution of S. litura on tobacco cv. ABD-101.

Keywords: Life tables, *Spodopteralitura*, Tobacco.

1. INTRODUCTION

Tobacco is grown in almost all parts of the world. In India, tobacco is grown on 0.45 M ha of area (accounting for only 0.31% of net cultivated area in the country) with 750 M Kg production. The world tobacco production is 7 billion Kg, China occupying the first place with 2.35 billion Kg. India stands second in tobacco production and exports in the world. Tobacco earns annually 4,402 crores as foreign exchange and 13,853 crores as excise revenue. Its total contribution to the national economy is 18,255 crores. Tobacco crop directly or indirectly supports 36 million people engaged in production, processing, marketing and exports which includes 6 million farmers and 5 million people involved in *bidi*-rolling and *tendu* leaf-plucking. Thus, the crop is a

lifeline for sizeable chunk of population, particularly rural women, triable's and other weaker sections of the society [1]. The *Spodoptera litura* (Fab.) commonly known as the tobacco caterpillar is generalist herbivore infesting more than 290 species of plants belonging 80 to 99 families [2], causes significant damage to different types of tobacco both under nursery and field conditions [3]. Damage due to *S. litura* in tobacco nursery varied from 80 to 100 per cent [4] and 10-25 per cent in the field crop [5] and reduce 23 to 50 per cent tobacco yield [6]. Application of life table, rate of increase and stable age distribution are almost as diverse as the other insects. Such life tables may be analyzed to determine which stage, the life cycle of insect, contribute the most to the population trend [7] and for determining the reproductive ability and biotic potential, statistics was developed to explain population increase[8]and[9].

2. MATERIALS AND METHODS

Insect Culture: The laboratory culture of *S. litura* was maintained on *bidi* tobacco c v. ABD-101 leaves for two consecutive generations at constant temperature of 26 ± 1 ˚C in Research Laboratory of *Bidi* Tobacco Research Station, AAU, Gujarat (India). For the study, newly emerged adults from the laboratory culture were kept for egg laying in 30 x 30 x 45 cm wooden cages. The sides of the cage were covered with muslin cloth. Tender leaves of the host plant were inserted into a conical flask containing fresh water to keep them fresh and turgid, and then placed into the cage for resting and oviposition of the adults. Egg masses laid on white muslin cloth or on leaves were used for this study.

Life Table Studies: In order to construct life tables, freshly 100 eggs were collected carefully from the egg masses in the cage with the help of wet camel hair brush and placed in ten Petri dishes (1.0 x 5.0 cm) in batches of ten each. On hatching, the larvae were transferred individually into plastic vials containing leaves of *bidi* tobacco cv. ABD-101. Fresh leaves were provided daily in the morning. Observations on hatching, larval development, formation of pupae and successful emergence of adults and fecundity were recorded daily. Age specific mortality in different developmental stages like eggs, larvae, pupae and adults were also recorded. With a view to determine the age specific fecundity, total number of adult emerged on the same day were caged in acrylic oviposition cage (30 x 30 x 30 cm) for oviposition. As the sex ratio was 1:1, the number of eggs obtained/ female were divided by 2 to get the number of female birth (mx). The column headings for the construction of the life fecundity tables proposed by Howe [9] and Atwal and Bains [10] were used in this study, *viz.*, x = Pivotal age in days; lx = Survival of female at age 'X'; mx = Age schedule for female births at age 'X'.

2.1. Net Reproductive Rate (Ro)

The values of 'x' and 'mx' were calculated from the data given in life tables. The sum total of the products 'lxmx' is the net reproductive rate (Ro) [11]. The 'Ro' is the rate of multiplication of population in generation measured in terms of female produced per generation. The number of times a population would multiply per generation was calculated by the following formula, Ro = ∑lxmx.

2.2. Mean Duration of Generation (Tc)

The appropriate value of generation time (Tc) *i.e.* the mean age of the mothers i a cohort at the birth of female offspring was calculated by using the following formula:

$$Tc = \sum xlxmx/Ro$$

2.3. Innate Capacity for Increase (rm)

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 (rc)' was derived by the following formula:

$$Rm = logeRo/Tc$$

Where,

Tc = Mean generation time

The intrinsic rate of increase (rm) was subsequently calculated from the arbitrarily 'rm' by taking two trial values selected on either side of it differing in the second decimal place and substituting in the equation $\sum e^{7-rmx}.lxmx$ [10]. Thus, the two values of the equation were found which lay immediately above or below 1097.

The values of $e^{7-rmx}lxmx$ obtained from the two trials were plotted against their respective arbitrarily 'rm' which give a straight line. The straight line was intersected by a vertical line drawn from the described value at 1097. The two point of intersection gave the accurate 'rm' value. The precise generation time (T) was calculated by using the following formula: T = logeRo/rm.

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

2.5. Stable Age Distribution

The stable age distribution (per cent distribution of various age groups) of *S. litura* on *bidi* tobacco cv. ABD-101 was worked out with the knowledge of 'rm' and the age specific mortality of the immature and mature stages were also calculated. The stable age distribution table was constructed by following the method of Andrewartha and Birch [12] and Atwal and Bains [10]. The 'Lx' (Life table age distribution) was calculated from the 'lx' table by using the following formula: Lx = Life table age distribution = lx + (lx + 1)/2.

Per cent distribution of each age group (x) was calculated by multiplying the Lx with $e^{-rm\,(x+1)}$. By putting together the percentage under each stage *viz.*, egg, larval, pupal and adult stages, the expected per cent distribution was worked out.

2.6. Life Table for Computing Life Expectancy *S. litura*

Life expectancy of the pest was worked out by using columns x, lx, dx, 100qx, Lx, Tx and ex.

Where, x = Pivotal age (days); lx = Number of surviving at the beginning of age interval out of 100; dx = Number daying during 'x'; 100qx = dx.100 /lx, Mortality rate per hundred alive at the beginning of age interval; Lx = lx + (lx + 1) /2, Alive between x and x + 1; Tx = Number of individual's life days beyond 'x' and

$$ex = \frac{Tx}{lx} \times 2, \quad \text{Expectation of further life}$$

Equations were formulated after processing the data I MS-Excel.

3. RESULTS AND DISCUSSION

The results on number of individual survived during development of *S. litura* on *bidi* tobacco cv. ABD-101 revealed that there was no mortality during egg stage and the maximum durations of egg, larva and pupa were 4, 22 and 14 days, respectively (Table 1). The number that survived from 100 eggs to adult emergence was 76 individuals. The contrasting results were reported by Baloliya [11] at Anand (Gujarat), he studied the life fecundity tables of *S. litura* on different varieties of tobacco and the data revealed that the highest survival of immature stages was recorded on GTH-1 followed by GT-5 and GT-7. According to [13] S. litura takes 51 and 55 days to complete its life cycle on mungbean and urdbean, respectively. On both crops survival decreased sharply initially, and then gradually decreased until the end of the generation and the maximum apparent mortality during the egg stage was 37 and 32 per cent on mungbean and urdbean, respectively. The survival fraction was lower and the mortality survival ratio was higher at the egg stage in both the crops. The total generation mortality was similar (0.3979) in both crops. The mean length of one generation was higher on urdbean (36.99 days) as compared to mungbean (33.64 days).

Life fecundity tables were constructed to determine the survival of female (lx) and age specific fecundity (mx). The life fecundity data presented in Tables 2 and 3 indicated that pre-oviposition period ranged from 41to 42days of pivotal age. Females deposited first batch of eggs on 43rd day and stopped it after 51st day with lx values being 0.76 and 0.13, respectively. The lx decreased gradually after 44th day of pivotal age due to adult mortality. The females contributed highest number of progeny (mx = 328.12) in the life cycle on the 45th day of pivotal age.

The net reproductive potential (Ro) was worked as 758.93 females/female with the mean generation time (T) was 45.67 days. The results are in confirmation with those of Bilapate, et al. [14], reported a net reproductive rate of (Ro) 766.82 days with the mean generation time of 41.08 days, respectively and by Garad, et al. [15] who reported that the net reproductive rate of 873.13 days females/female on castor. Results are disagreed from those reported by Bharathi, et al. [16], who found that the net reproductive rate (Ro) was 338.74 in lanka tobacco followed by hookah (310.38) and cigar wrapper (235.54). [17] at Kandukur (Andhra Pradesh) found that the net reproductive rate (Ro) was 324.59 females per female per day, potential fecundity (P_f) (1783.64) and mean generation time (27.84 days) of *S. litura* when reared on FCV tobacco.[18] at Coimbatore (Tamil Nadu, India) studied the life tables of *S. litura* on cauliflower leaves treated with gibberellic acid and *Pseudomonas fluorescence* and they revealed that the value of net

reproductive rate (Ro) was 420.05 and 360.90, indicating that the population of *S. litura* was able to multiply 420.05 and 360.90 times on the untreated and treated leaves in the generation time (T) of 33.18 and 34.03 days, respectively.

The intrinsic rate of increase (rm) and finite rate of natural increase in numbers (λ) as 0.1462 and 1.1574 females/female/day, respectively. Weekly multiplication of population was calculated 2.78 times per week. The hypothetical females population in F_2 generation was 575974.70. The similar results were reported by Baloliya [11], according to him the intrinsic rate of natural in numbers (rm) was ranged from 0.1503 to 0.1594 females per female per day on different varieties. Similarly, the finite rate of increase in numbers (λ) ranged from 1.162 to 1.173 females per female per day on GTH-1, GT-5 and GT-7 varieties of tobacco. However, [16] reported that the intrinsic rate of increase (rm) was maximum (0.2014) on hookah tobacco followed by lanka (0.1907) and cigar wrapper tobacco (0.1811).

It could be noticed that on reaching the stable age distribution, the population in its various stages *viz*., eggs, larvae, pupae, and adults contributed to the extent of 52.64, 45.86, 1.36 and 0.12 per cent, respectively (Table 3). Similar results were also reported by Hemchandra and Singh [19] and Mondal, et al. [7]with their studies on *Plutella xylostella* feeding on cauliflower and *Creatonotus gangis* when reared on artificial diet. Therefore, the present findings revealed that the immature stages (egg, larva and pupa) contributed major proportion on stable-age distribution of this insect and these stages should be included during sampling to find out the true size of population.

The computation of life expectancy table of *S litura* on *bidi* tobacco c v. ABD-101 (Table 4) clearly showed that the life expectancy of newly deposited eggs was 16.19 days. Further, it has been clearly observed that the mortality rate was comparatively high at the age of 40 to 45 days, when the expectation of further life was reduced to 2.83 days from 16.19 days in the beginning. Almost similar observations of *S. litura* was recorded on tobacco and [11] at Anand and [16] and [20] at Rajahmundry also found more or less similar observations on life fecundity tables when *S. litura* reared on different tobacco hosts.

REFERENCES

[1] V. Krishnamurthy, "Tobacco new dimensions." Available http://www.ctri.org.in/pages/new.pdf, 2011.

[2] C. J. Wu, S. Y. Fan, Y. H. Jiang, and A. B. Zhang, "Inducing gathering effect of taro on spodoptera litura fabricius," *Chinese J. Ecol*., vol. 23, pp. 172-174, 2004.

[3] G. M. V. Rao, S. Saralamma, and K. Sudhakar, "Management of the tobacco leaf eating caterpillar spodoptera litura fabricius in cigarette nattu tobacco," *Tobacco Res*., vol. 30, pp. 1-10, 2004.

[4] M. S. Chari, T. M. Bharpoda, and A. R. Patel, "Bio-efficacy of fluvalinate against spodoptera litura fabricius in tobacco nursery," *Pestology*, vol. 10, pp. 21-24, 1986.

[5] S. Sitaramaiah, U. Sreedhar, G. Ramaprasad, and S. V. V. Satyanarayana, "Management of tobacco leaf eating caterpillar, spodoptera litura fabricius with insecticide baits in NLS tobacco," *Tobacco Res*., vol. 27, pp. 7-11, 2001.

[6] H. K. Patel, N. G. Patel, and V. C. Patel, "Quantitative estimation of damage to tobacco caused by the leaf-eating caterpillar," *Prodenia litura Fb. Pans*, vol. 17, pp. 202-205, 1971.

[7] P. Mondal, A. K. Bhattacharya, and K. C. Chenchaiah, "Application of new software programmes: Life table of creatonotus gangis on artificial diet," *Ann. Pl. Protec. Sci*., vol. 15, pp. 358-365, 2007.

[8] L. C. Birch, "The intrinsic rate of natural increase of an insect population," *J. Animal Ecol*., vol. 17, pp. 15-26, 1948.

[9] R. W. Howe, "The rapid determination of intrinsic rate increase of an insect population," *Annual Rev. of App. Biol*., vol. 40, pp. 134-155, 1953.

[10] A. S. Atwal and S. S. Bains, *Applied animal ecology*. Ludhiana: Kalyani Publishers, 1974.

[11] K. F. Baloliya, "Biology of spodoptera litura fabricius on different hosts, its population dynamics and management in tobacco nursery," M.Sc. (Agri.) Thesis Submitted to Gujarat Agricultural University, Sardar Krishinagar, 2001.

[12] H. C. Andrewartha and C. C. Birch, *The distribution and abundance of animals*. Chicago: University of Chicago Press, 1954.

[13] M. H. Dar, P. Q. Razvi, and N. A. Naqvi, "Age and stage specific life tables of spodoptera litura fabricius on mungbean and urdbean," *Indian J. Pulses Res*., vol. 16, pp. 39-41, 2003.

[14] G. G. Bilapate, V. M. Pawar, and U. T. Thombre, "Life tables and intrinsic rates of increase of spodoptera litura fabricius on sunflower," *Indian J. Agric. Sci*., vol. 50, pp. 273-277, 1980.

[15] G. P. Garad, P. R. Shivpuje, and G. G. Bilapate, "Life fecundity tables of spodoptera litura fabricius on different hosts," *Indian Aca. Sci. Animal Sci*., vol. 93, pp. 29-33, 1984.

[16] J. L. Bharathi, U. Srieedhar, B. Kishore, J. V. Prasad, and J. A. V. Prasad Rao, "Life table studies of spodoptera litura on different types of tobacco," *Tobacco Res*., vol. 33, pp. 36-42, 2007.

[17] J. V. Prasad, "Comparative life table studies of spodoptera litura fabricius and spodoptera exigua on FCV tobacco seedlings under southern light soil conditions," *Tobacco Res*., vol. 30, pp. 42-47, 2004.

[18] A. M. Sundaram, N. Dhandapani, N. Sathiah, and J. Stanley, "Life table studies of spodoptera litura fabricius on cauliflower leaves treated with gibberellic acid and pseudomonas fluorescens (Migula)," *J. Pl. Prot. and Environ*., vol. 3, pp. 15-20, 2006.

[19] O. Hemchandra and T. K. Singh, "Life table, rate of increase and stable-age distribution of plutella xylostella (Linnaeus) on cauliflower," *Ann. Pl. Protec. Sci*., vol. 11, pp. 269-273, 2003.

[20] J. L. Bharathi, U. Srieedhar, B. Kishore, J. V. Prasad, and K. S. Raju, "Differential response of types of tobacoo to spodoptera litura fabricius," *Indian J. Entomol*., vol. 70, pp. 123-130, 2008.

Table-1. Survival of different life stages of *Spodoptera litura* on *bidi* tobacco (cv. ABD-101)

No. of eggs	No. survived (Days)			
	Egg stage (0-4)	**Larval stage (5-26)**	**Pupal stage (27-40)**	**Adult stage (41-51)**
10	10	10	10	10
10	10	7	7	7
10	10	5	4	4
10	10	9	9	9
10	10	8	8	8
10	10	10	8	8
10	10	6	6	6
10	10	10	10	10
10	10	9	9	9
10	10	8	5	5
100	**100**	**82**	**76**	**76**

Table-2. Mean length of generation, innate capacity for increase in numbers and finite rate of increase in numbers of *Spodoptera litura* on *bidi* tobacco (cv. ABD-101)

Population growth statistics	**Formula**	**Calculated values**
Net reproductive rate	Ro=∑lxmx	758.9303
Mean length of generation	$Tc = \frac{\sum xlxmx}{Ro}$	45.67 days
Innate capacity for increase in numbers	$rm = \frac{logeRo}{Tc}$	0.1456 Female/ female/ day
Arbitrarily 'rm' (rc)	0.14 and 0.15	
Corrected 'rm'	∑e7-rmx*lxmx	0.1462 Female/ female/ day
Corrected generation time	$T = \frac{LogeRo}{rm}$	45.38 days
Finite rate of increase in numbers	λ = anti log e ^{rm}	1.1574 Female/ female/ day
Weekly multiplication of population	$(\lambda)^7$	2.7824 Female/ female/ day
Hypothetical F_2 females	$(Ro)^2$	575974.7

Table-3. Age specific distribution of *Spodoptera litura* on *bidi* tobacco (cv. ABD-101) (rm = 0.1462)

Pivotal age in (days) 'x'	Lx	Age schedule for female births (mx)	(lxmx)	(xlxmx)	$e^{-rm(x+1)}$	$Lx.e^{-rm}_{(x+1)}$	Per cent contribution
0	1.00	-	-	-	0.8640	0.8640	13.8083
1	1.00	-	-	-	0.7465	0.7465	11.9302
2	1.00	-	-	-	0.6449	0.6449	10.3075
3	1.00	-	-	-	0.5572	0.5572	8.9055
4	1.00	-	-	-	0.4814	0.4814	7.6942
							=52.6457
5	1.00	-	-	-	0.4159	0.4159	6.6477
6	1.00	-	-	-	0.3594	0.3594	5.7435
7	1.00	-	-	-	0.3105	0.3105	4.9623
8	1.00	-	-	-	0.2683	0.2683	4.2874
9	1.00	-	-	-	0.2318	0.2318	3.7042
10	1.00	-	-	-	0.2002	0.2002	3.2004
11	0.98	-	-	-	0.1730	0.1696	2.7098
12	0.98	-	-	-	0.1495	0.1465	2.3412
13	0.98	-	-	-	0.1291	0.1266	2.0228
14	0.97	-	-	-	0.1116	0.1082	1.7298
15	0.97	-	-	-	0.0964	0.0935	1.4945
16	0.95	-	-	-	0.0833	0.0791	1.2646
17	0.93	-	-	-	0.0720	0.0669	1.0696
18	0.92	-	-	-	0.0622	0.0572	0.9142
19	0.90	-	-	-	0.0537	0.0483	0.7727
20	0.88	-	-	-	0.0464	0.0408	0.6527
21	0.88	-	-	-	0.0401	0.0353	0.5640
22	0.88	-	-	-	0.0346	0.0305	0.4873
23	0.87	-	-	-	0.0299	0.0260	0.4162
24	0.83	-	-	-	0.0259	0.0215	0.3431
25	0.80	-	-	-	0.0223	0.0179	0.2857
26	0.80	-	-	-	0.0193	0.0154	0.2468
							=45.8604
27	0.80	-	-	-	0.0167	0.0133	0.2133
28	0.80	-	-	-	0.0144	0.0115	0.1842
29	0.80	-	-	-	0.0125	0.0100	0.1592
30	0.80	-	-	-	0.0108	0.0086	0.1375
31	0.80	-	-	-	0.0093	0.0074	0.1188
32	0.80	-	-	-	0.0080	0.0064	0.1027
33	0.80	-	-	-	0.0069	0.0056	0.0887
34	0.80	-	-	-	0.0060	0.0048	0.0766
35	0.80	-	-	-	0.0052	0.0041	0.0662
36	0.80	-	-	-	0.0045	0.0036	0.0572
37	0.80	-	-	-	0.0039	0.0031	0.0494
38	0.80	-	-	-	0.0033	0.0027	0.0427
39	0.80	-	-	-	0.0029	0.0023	0.0369
40	0.80	-	-	-	0.0025	0.0020	0.0319
Survival of female at different age interval							**=1.3654**
41	0.76	**Pre-oviposition stages**			0.0022	0.0016	0.0262
42					0.0019	0.0014	0.0226
43	0.76	67.13	51.02	2193.81	0.0016	0.0012	0.0195
44	0.76	133.24	101.26	4455.55	0.0014	0.0011	0.0169

45	0.71	328.12	232.97	10483.43	0.0012	0.0009	0.0136
46	0.68	247.00	167.96	7726.16	0.0010	0.0007	0.0113
47	0.57	188.33	107.35	5045.36	0.0009	0.0005	0.0082
48	0.47	153.17	71.99	3455.52	0.0008	0.0004	0.0058
49	0.23	88.67	20.39	999.31	0.0007	0.0002	0.0025
50	0.15	30.23	4.53	226.73	0.0006	0.0001	0.0014
51	0.13	11.21	1.46	74.32	0.0005	0.0001	0.0010
			Ro=∑lxmx =758.93	**∑xlxmx =34660.18**	-	**=6.2570**	**=0.1289**

Table-4. Life table for computing life expectancy of *Spodoptera litura* on *bidi* tobacco (cv. ABD-101)

Pivotal age (Days) 'x'	Number of surviving to the beginning of age interval	Number of dying during 'x'	Mortality rate per hundred alive at beginning age interval $\left(\frac{dx \cdot 100}{lx}\right)$	Alive between age 'x' and 'x+1' $\frac{lx + (lx+1)}{2}$	No. of the individuals life days beyond 'x'	Expectation of further life $\frac{Tx}{lx} \times 2$
(x)	(lx)	(dx)	(100 qx)	(Lx)	(Tx)	(ex)
0-5	100	0	0.00	100.5	809.5	16.19
5-10	100	3	3.00	100.5	709	14.18
10-15	97	9	9.28	97.5	608.5	12.55
15-20	88	8	9.09	88.5	511	11.61
20-25	80	0	0.00	80.5	422.5	10.56
25-30	80	0	0.00	80.5	342	8.55
30-35	80	0	0.00	80.5	261.5	6.54
35-40	80	9	11.25	80.5	181	4.53
40-45	71	56	78.87	71.5	100.5	2.83
45-50	15	2	13.33	15.5	29	3.87
50-55	13	0	0.00	13.5	13.5	2.08

Fig-1. Age-specific survival (lx) and fecundity (mx) curve of *Spodoptera litura* on *bidi* tobacco (c v. ABD-101)