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Research Article

Effect of Host Plants on Life Table Parameters of *Spodoptera litura*

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ABSTRACT

Life table parameters of Spodoptera litura (Fabricius) was studied on castor, cabbage and cauliflower. Hatchability of eggs was recorded 100 % on all host plants. Survivorship was 35 days on castor and 38 days on cabbage and cauliflower. Highest mortality occurred in the pupal stage (46.11, 43.87 and 38.72 %) on castor, cabbage, and cauliflower, respectively. The net reproductive rate was found highest on castor 476.92 (females/female/generation) while on cauliflower 340.61. The highest intrinsic rate of increase was 0.2069 female/female/day on castor compared to 0.1836 on cauliflower. Finite rate of increase was 1.23, 1.21, 1.20 females/female/day for castor, cabbage, and cauliflower, respectively. Mean length of the generation was significantly higher on cauliflower (31.94 days) castor. The population of S. litura will become double in a short period (3.35 days) on castor compared to cabbage (3.71) and cauliflower (3.78), respectively. It can be inferred from the above parameters that castor is a suitable host for S. litura and it may also be used as trap crop to prevent the attack of economically important crops.

Key words: *Tobacco, Pyrethroids, Caterpillar, Groundnut, Maize, Mung bean, Potatoes*

INTRODUCTION

Tobacco caterpillar, *Spodoptera litura* (Fabricius) (Lepidoptera: Noctuidae) is a polyphagous pest and widely distributed throughout south east Asia, Australia, and Pacific Islands[23]. It has been reported to feed about 180 species of plants universally[30,22]. This pest is infesting some economically Important crops including tobacco, taro, cabbage, cauliflower, castor, cotton, groundnut, maize, mung bean, potatoes, soybean, rice, sunflower, tomato, etc[15]. It causes excessive damage ranging from 26 to 100 % by its vigorous defoliation[38] and sometimes up to 100% in the field condition[29]. In India, it is distributed throughout the Andhra Pradesh, Bihar, Haryana, Maharashtra, Madhya Pradesh, Rajasthan, Tamil Nadu, Uttar Pradesh[33]. It also has been developed resistance to many commonly used insecticides, particularly pyrethroids and carbamates, failing effective controls[22,2,19].

Life table parameters of *S. litura* on different host plants would provide crucial information on damaging stages. It is an essential tool in the measurement of population growth capacity of species under specified conditions[31].

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The obtained information may be implemented for the future development of IPM programs against *S. litura* including analyzing population stability and structure, estimating extinction probabilities, predicting life history evolution, predicting outbreak in pest species, and examining the dynamics of colonizing or invading species[35,17]. This information may also be useful in constructing population models[8,9] and understanding interrelationship with other insect pest species and biocontrol agents[26].

MATERIAL AND METHODS

Place of study: Present study was carried out at the D/o Plant Protection, F/o Ag. Sciences, Aligarh Muslim University, Aligarh at 27±2°C temp. and 70±10% RH located between 27.923401" N, 78.074317" E.

Stock culture: Adult moths of *S. litura* were collected from the department at night time near a light source and kept in rearing glass jar provided with 10 per cent honey solution in cotton swab for food. They were maintained at 27±2°C and 70-80 % relative humidity. Fresh tender leaves of castor were placed into glass jars with zig-zag paper stripes for oviposition. Eggs were collected from paper strips and kept in rearing jars (22X18 cm). After hatching first instars transferred to plastic containers (100 ml) provided with fresh soft leaves of castor, cabbage, and cauliflower. After the third instar, larvae were allowed to feed separately. Dead larvae discarded and the food was changed daily till pupation. Hygienic conditions were maintained during the experiment period. Two generations maintained to acclimatize the lab. Conditions. The adults emerged from pupae were further used for life table studies after two generations.

Life table studies: For the construction of life table, 100 eggs (3 reps.) were used from egg-mass of third generation with the help of soft hair brush and placed in small plastic containers for hatching. After hatching, leaves from three host plants namely *Ricinus communis* (castor), *Brassica oleracea* (L.) (cabbage) and *B. oleracea* var. *botrytis* (cauliflower) were provided to the larva as food in this study till pupation. Grown-up larvae were transferred into the rearing glass jar, one third filled with moistened sterilized soil for pupation. After emergence, the adults were transferred to jars and wooden rearing boxes for mating.

Observations were made daily at the interval of 24 hours. Number of hatched eggs were counted at the time of hatching. Dead and alive individual recorded daily to construct the age specific life table. Similarly, mortality in each stage was also recorded to form stage-specific life table. Dead larvae and malformed pupae were discarded every day. The life table on castor, cabbage and cauliflower constructed by using method of Deevey[12] and Southwood[32]. After emergence, male and female were paired and kept in a glass jar and method of rearing is same as mentioned above and it was replicated three times to study the fecundity. The number of eggs laid by females recorded daily from the day after emergence up to the death of females. The number of eggs divided by sex ratio 1:1 to get the number of female birth (m_x).

The fertility table is constructed with following columns:

X = Pivotal age in days

l_x = Number of females alive at the beginning of age interval x (x- pivotal age) as a fraction of initial population of one[7]

m_x = Nx/2 where, N_x is total natality/female

Reproductive expectation: $l_x.m_x$ is also computed by multiplying the column lx with mx.

Many parameters computed from the age-specific survival and fertility table of the female. This includes:

1. Potential fecundity (P_f): $P_f = \sum m_x$
2. Net reproductive rate $R_o = l_x.m_x$
3. $T_c = \sum_x$. lx/lx.mx
4. $r_m = \log_e R_o/T_c$

$$\sum e^{.rm} l_x.m_x.d_x = 1 \text{ Lotka (1925)}$$

5. Finite rate of increase (λ): Antilog (r_m)
6. $DT = \log_e 2/r_m$

RESULTS

Effect of host plants on age-specific life table:

The results (fig. 1) revealed that survivorship was affected by host plants. It survived for 35 days on castor but increased to 38 days on cabbage and cauliflower. Expectancy of life was highest on cauliflower (23.16) followed by castor (22.63) and cabbage (21.75) at the beginning of age and declined with age. Mortality was not recorded in egg stage with 100 % hatching. Highest mortality was observed on 25th day on castor, 29th day on cabbage and 28th day on cauliflower as well as fluctuation in mortality was recorded in different instars. Emergence was also affected by host plants. It was 34 on castor, 35 on cabbage and 29 % on cauliflower. Results showed that the incubation period was almost the same (3 days) in case of all hosts: castor, cabbage, and cauliflower with 100 % hatching of the eggs.

Stage-specific life table:

The data (Table 1) showed that the apparent mortality was maximum at pupal stage (castor 46.87; cabbage 42; cauliflower 39.65%) followed by V instar on cabbage 15.27 % and pre-pupal stage of castor 13.51 %, cauliflower 12.12 %) and no mortality (0 %) recorded on egg stage in all hosts. Survival fraction (S_x) was higher on castor (0.9800), and cauliflower (0.9700) at I instar followed by cabbage (0.9600) at IV instar and highest in egg stage (1.00) on all hosts. Mortality survival ratio was revealed that maximum value was found on the pupal stage on all host plants and lowest on egg stage. It was highest on cauliflower and lowest on cabbage on pre-pupal stage. Pupal stage was more susceptible on castor than cauliflower host. Indispensable mortality (IM) was found maximum on castor followed by cauliflower and minimum on cabbage. Generation mortality (K – Values) was found to be maximum (0.2747) at the pupal stage on castor, and the minimum (0.0088) at I instar on castor. However, the sum of k – values obtained for all developmental stages were 0.4685 for castor, 0.5376 for cabbage and 0.4559 for cauliflower.

Effects of hosts on the life indices:

Results revealed that host plants affected the natality rate (m_x) of *S. litura*. Female of *S. litura* commenced egg laying during a definite period of pivotal age. The most extended duration of natality was 8 days on cabbage and cauliflower followed by 7 days on castor. Highest egg laying was noticed on 3rd and 4th day after emergence then decreased with age on all hosts. Peak fecundity occurred (718.33 females) on castor on the pivotal age of 29.5th day followed by cabbage (683.33) on 31.5th day and cauliflower (573.33) on 32.5th of pivotal age. Post- oviposition period was 1 days on all host plants.

Results (Table 2) revealed that host plants affected the life indices of *S. litura*. Potential fecundity (P_f) was highest on castor (3066.33 females/generation) followed by cabbage (2828.33) and lowest on cauliflower (2742.33) ($F = 16.24$; df = 2,8; $P = 0.012$). Net reproductive rate was significantly highest on castor (476.92 females/female/generation) compared to 340.61 cauliflower ($F = 6.81$; df = 2,8; $P = 0.052$). Intrinsic rate of increase (r_m) was also highest on castor (0.2069 females/female/day) and lowest on cabbage and cauliflower (0.1866 and 0.1836, respectively) ($F = 18.79$; df = 2,8; $P = 0.009$). Finite rate of increase (λ) was significantly highest on castor (1.23) compared to cabbage and cauliflower ($F = 19.06$; df = 2,8; $P = 0.009$). Similarly, mean generation time and corrected generation time were non-significant between cabbage and cauliflower, however significant in castor ($F = 93.88$; df = 2,8; $P = 0.987*T_c$; $F = 100.25$; df = 2,8; $P = 0.989*\tau$). Population will become double in a short period of time on castor (3.35 days) compared to cabbage and cauliflower ($F = 16.020$; df = 2,8 $P = 0.012$).

DISCUSSION

We found that the survival and reproduction of *S. litura* were affected by host plants. Larvae can survive on all hosts tested. In general, host suitability for any species is characterized by some fundamental ecological and demographical parameters such as mean daily

fecundity, survival, development time and sex ratio. Generally, short development time, higher reproduction rate and low mortality of insect on a host indicate the greater suitability of a host plant[3]. These parameters are of great importance in insect pest management. Present studies suggested that cauliflower, castor, and cabbage were the most suitable hosts for the better development, reproduction and population buildup of *S. litura*.

The incubation period was three days with 100 % hatching on all hosts; castor, cabbage, and cauliflower. Relatively similar results observed by Bae *et al*.[5], and Patil *et al*.[28], who reported 100 % hatchability of egg masses on the leaf of soybean and tobacco (var. Anand-119).

Moreover, the quality of food is also one of the possible factors affecting the duration of immature development[14]. Kursar *et al*.[24], mentioned that the growth of Lepidoptera was slower when they fed on leaves with the higher amount of crude fibre and less protein. Also, some secondary metabolites and toxic proteins also responsible for slow development[18,36].

In our study, potential fecundity, net reproductive rate, intrinsic rate of increase and infinite rate of increase was highest on castor; mean generation time, corrected generation time and doubling time also found shortest on castor. It is; therefore, castor is preferred host plant compared to cabbage and cauliflower. The present findings are somewhat similar with the results but not entirely: Balasubrimanian *et al*.[6], reported that net reproductive rate was 547.18 on castor and 358.76 on cotton with intrinsic rate of natural increase (0.1935) which is about same to value (476.92 castor, 362.57 cabbage R_o; 0.2069 on castor). Dar *et al*.[10], reported that mean length of generation was prolonged to 33.64 days on urdbean compared to present finding. Finite rate of increase was found higher in the results of Gedia *et al*.[16], who found 1.19 females/female/days on groundnut cv. GG 20 at 27^{o}C. However, intrinsic rate of increase was also relatively similar with the report of Tuan *et al*.[34], that was 0.1828, 0.1545 f/f/day at a constant temperature of 25^{o}C, whereas Patil *et al*.[28], were also found 1.16 females/female/day. Dara and Prasad[11] observed net reproductive rate, intrinsic and finite rate of increase and potential fecundity were high on castor bean. Garad *et al*.[15], also reported the innate capacity of increase (0.2072) on sunflower which is nearby to castor. Jadhav *et al*.[21], found net reproductive rate 499.2 females/ generation which was relatively higher than our findings and Dhandapani *et al*.[13], studied life-table on the banana and reported very close (479.15 females) to our value (476.92 females) on castor. Yadav *et al*.[37], also found that cauliflower was the most preferred host by larval and pupal periods, survival per cent, incubation period, fecundity and sex ratio in comparison to pea, spinach and tobacco. Results are also parallel with the work of Ouyang, and Ouyang[27] who recorded (rm) were 0.2001 and 0.2140 and finite rates of increase (λ) 1.2215, 1.2386. Bharathi *et al*., reported net reproductive rate 338.74 and rm 0.2014 on Lanka tobacco with rm value of 0.1811 and mean generation time of 32.20 days cigar filler. Ahmad *et al*.[1], also concluded castor and cabbage are the most suitable hosts.

Table 1. Stage specific life table of *S. litura* on host plants

Stages	Survivors at beginning	Mortality	Apparent mortality	Survival Fraction	Mortality/ Survival ratio	Indispensable mortality	log	
x	***lx***	***dx***	***100qx***	***Sx***	***MSR***	***IM***	***lx***	***k-values***
Castor								
Egg	100	0	0.000	1.0000	0.0000	0.000	2.0000	0.0000
I instar	100	2	2.000	0.9800	0.0204	0.612	2.0000	0.0088

II instar	98	12	12.245	0.8776	0.1395	4.186	1.9912	0.0567
III instar	86	4	4.651	0.9535	0.0488	1.463	1.9345	0.0207
IV instar	82	2	2.439	0.9756	0.0250	0.750	1.9138	0.0107
V instar	80	4	5.000	0.9500	0.0526	1.579	1.9031	0.0223
VI instar	76	2	2.632	0.9737	0.0270	0.811	1.8808	0.0116
Pre-Pupa	74	10	13.514	0.8649	0.1563	4.688	1.8692	0.0631
Pupa	64	30	46.875	0.5313	0.8824	26.471	1.8062	0.2747
Adult	34	0	0.000	0.0000	0.0000	0.000	1.5315	0.0000
							K=	**0.4685**
Cabbage								
Egg	100	0	0.000	1.0000	0.0000	0.000	2.0000	0.0000
I instar	100	7	7.000	0.9300	0.0753	2.258	2.0000	0.0315
II instar	93	11	11.828	0.8817	0.1341	4.024	1.9685	0.0547
III instar	82	7	8.537	0.9146	0.0933	2.800	1.9138	0.0388
IV instar	75	3	4.000	0.9600	0.0417	1.250	1.8751	0.0177
V instar	72	11	15.278	0.8472	0.1803	5.410	1.8573	0.0720
VI instar	61	6	9.836	0.9016	0.1091	3.273	1.7853	0.0450
Pre-Pupa	55	5	9.091	0.9091	0.1000	3.000	1.7404	0.0414
Pupa	50	21	42.000	0.5800	0.7241	21.724	1.6990	0.2366
Adult	29	0	0.000	0.0000	0.0000	0.000	1.4624	0.0000
							K=	**0.5376**
Cauliflower								
Egg	100	0	0.000	1.0000	0.0000	0.000	2.0000	0.0000
I instar	100	3	3.000	0.9700	0.0309	0.928	2.0000	0.0132
II instar	97	8	8.247	0.9175	0.0899	2.697	1.9868	0.0374
III instar	89	8	8.989	0.9101	0.0988	2.963	1.9494	0.0409
IV instar	81	4	4.938	0.9506	0.0519	1.558	1.9085	0.0220
V instar	77	4	5.195	0.9481	0.0548	1.644	1.8865	0.0232
VI instar	73	7	9.589	0.9041	0.1061	3.182	1.8633	0.0438
Pre-pupa	66	8	12.121	0.8788	0.1379	4.138	1.8195	0.0561
Pupa	58	23	39.655	0.6034	0.6571	19.714	1.7634	0.2194
Adult	35	0	0.000	0.0000	0.0000	0.000	1.5441	0.0000
							K=	**0.4559**

Table 2. Effects of host plants on life indices of *S. litura*

Host	*pf*	*Ro*	*rm*	*λ*	*Tc*	*τ*	*DT*
castor	3066.33[a]	476.92[a]	0.2069[a]	1.23[a]	30.00[b]	29.81[b]	3.35[b]
cabbage	2828.33[b]	362.57[b]	0.1866[b]	1.21[b]	31.79[a]	31.58[a]	3.71[a]
cauliflower	2742.33[b]	340.61[b]	0.1836[b]	1.20[b]	31.94[a]	31.76[a]	3.78[a]
LSD (P<0.05)	163.5	109.68	0.0116	0.01	0.44	0.426	0.23
Df	2,8	2,8	2,8	2,8	2,8	2,8	2,8
F	16.24	6.81	18.79	19.06	93.88	100.25	16.02

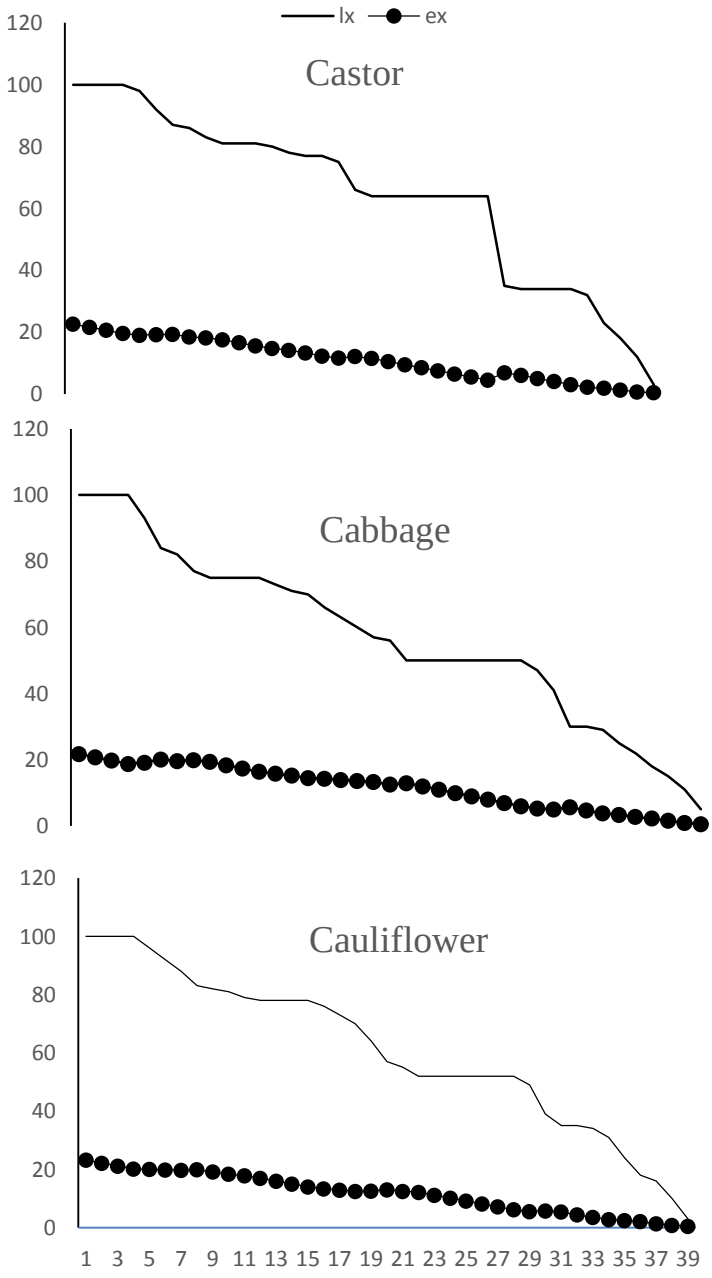

Figure 1. Effect of host plants on the survival (Ix) and expectancy (ex) of *S. litura*

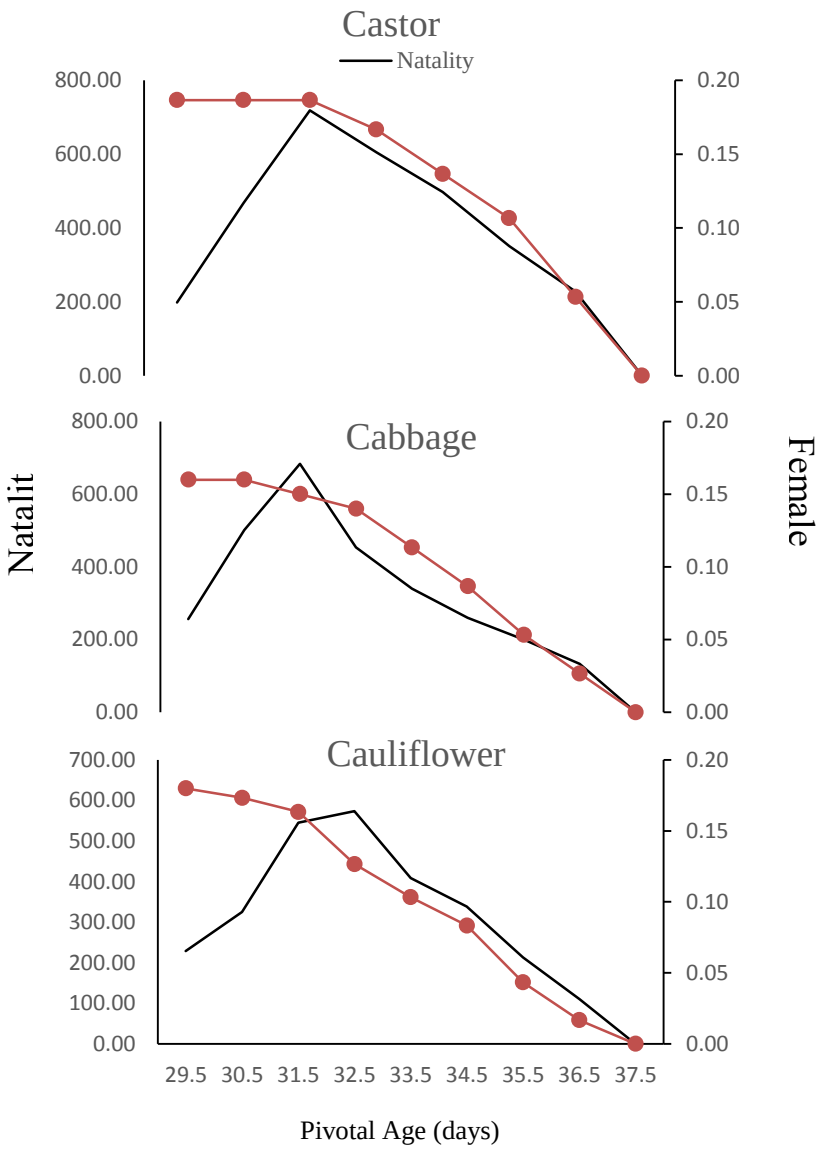

Figure 2. Effect of host plants on female survival and natality of *S. litura*

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