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Investigations on *Heliothis armigera* Hubner in Marathwada. V. Life Fecundity Tables on Sunflower and Maize*

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Life tables of *H. armigera* were prepared from daily fecundity and survival d ta of a cohort, when larvae were reared on sunflower leaves and maize cobs at a constant temperature of 26 ± 1^0C. The intrinsic rates of increase (r_m) were found to be 0.1328 and 0.1257 individuals per female per day and the population multiplied (R_0) 368.61 and 254.33 times in a generation time (T) of 44.50 and 44.05 days. The theoretical stable age-distribution on sunflower was 52.07% eggs, 43.27% larvae, 4.20% pupae and 0.41% adults while 50.45 eggs,44.40 larvae, 4.65 pupae and 0.49% adults on maize.

Key Words: Life Fecundity tables, *Heliothis armigera* **(Hubner)**

Introduction

The American cotton bollworm, *Heliothis armigera* (Hubner) is a pest of cotton, pigeonpea, sorghum, chickpea and sunflower in the Marathwada region of the Maharashtra State. Studies on *H. armigera* in this region have been mainly limited to papers on its biology (Bilapate & Pawar 1977a, b, Bilapate & Raodeo 1977). Life tables are helpful in studies on insect population dynamics. In this article we present life tables of *H. armigera* on sunflower and maize.

Materials and Methods

The method used in this work was similar to that given earlier (Bilapate et al. 1977, Bilapate et al. 1978, Bilapate & Pawar 1978). A cohort consisting of 100 eggs was used to construct the life-fecundity tables for *H. armigera* reared on sunflower (*Helianthus annuus* Linn.) leaves and maize (*Zea mays* Linn.) cobs. After hatching, all the larvae were reared individually in circular plastic boxes

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(5 × 5 cm) on fresh food supplied every day. Observations were made on hatching, larval and pupal development, successful adult emergence, fecundity and age specific mortality in respective stages. The life-tables were constructed for *H. armigera* according to the method of Birch (1948) and Watson (1964). All the tests were made under laboratory conditions at a constant temperature of 26±1°C. Birch (1948) defined the intrinsic rate of increase of a population under specified constant environmental conditions in which space and food are unlimited when there are no mortality factors other than the physiological ones. According to him it is the rate of increase in insect population per head under specified physical conditions where the effects of increasing density do not need to be considered. The values of X, l_x and m_x were calculated from the data in life-tables (Birch 1948, Howe 1953). The intrinsic rate of increase was calculated from the data in life-table by using the formula $e^{-r}m^{x}l_x m_x{=}1$, where e is the base of logarithm, X is the age of individuals in days, l_x is the number of individuals alive at age X as a portion of one and m_x is the number of female offsprings produced per female in the age interval X. The values of X, l_x and m_x were taken from the life-history records. The values of the negative exponent of $e^{-r}m^{x}$ ascertained from this experiment often lay outside the range given in the table found in most mathematical handbooks. For this reason, both sides of the above equation were multiplied by a factor of $\Sigma e^{7-r}\,m^{x}l_x m_x{=}1096.6$ (Birch 1948, Watson 1964). Arbitrary values of r_m to two decimal places were substituted in the formula until the two values of the equation $(e^{7-r}m^{x}l_x m_x)$ were found which lie immediately above and below 1096.6. The values of $\Sigma e^{7-r}m^{x}l_x m_x$ were then plotted on the horizontal axis (figure 2). The points were joined to give a line which intersected a vertical line drawn from the desired values of the said formula. The points of intersection gives the r_m accurate to four decimal places. The stable age-distribution was worked out with the knowledge of r_m and the age specific mortality of immature as well as mature stages.

Results and Discussion

The data on the survival of different stages of *H. armigera* during development on sunflower and maize are presented in table 1. The maximum duration of eggs, larvae and pupae were 4, 16 and 16 days, respectively for sunflower and maize. The successful development of immature stages from egg to adult emergence was 63 and 60%, respectively. It is obvious from table 2 that the survival of the immature stages (l_x) from the egg to the adult stage on the sunflower and maize was 63 and 60%, respectively. The substantial contribution (m_x =139.90 female-births) in the life cycle on sunflower was made by the female on 45th day of pivotal age. While it was 101.43 (m_x) on 44th day of pivotal age i.e. on 8th day of adult emergence. The fecund.ty curve can be characterised as slowly rising to a plateau followed by a decline to zero (figure 1). The survival of females declined from 12th day after emergence (l_x=0.61) on sunflower. The net reproductive rate (R_o) representing the total female-births were 368.61 and 254.33 on sunflower and maize, respectively. The results obtained on the innate capacity for increase in numbers (r_m) and finite rate (λ) and mean generation time (T) of *H. armigera* are presented in table 3 and figure 2. It is evident that the mean time required to complete one

Table 1 *The survival of diffetent stages of* H. armigera *during development on sunflowers and maize*

Eggs kept	Number surviving		
	Egg stage 0—4 days	Larval stage 5—20 days	Pupal stage 21—36 days
Sunflower			
10	10	8	6
10	10	8	7
10	8	8	6
10	10	8	7
10	9	7	6
10	9	7	7
10	9	7	6
10	9	7	6
10	8	6	6
10	8	6	6
100	90	72	62
Maize			
10	10	6	6
10	10	7	6
10	10	7	6
10	8	7	6
10	8	7	6
10	8	6	6
10	9	7	6
10	9	7	5
10	9	7	5
10	9	9	8
100	90	70	60

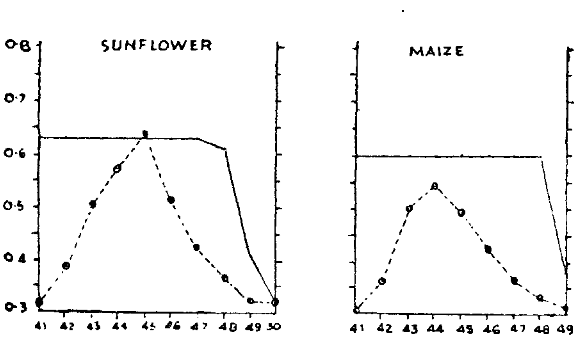

Figure 1 Daily age-specific survival and fecundity of *H. armingera* on sunflower and maize

X Axis—Pivotal age in days (*X*)
Y Axis—Age-specific survival (l_x)

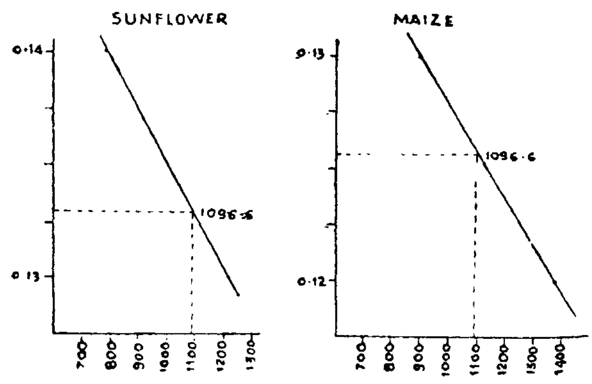

Figure 2 Determination of the intrinsic rate of increase (r_m) of *H. armigera* on sunflower and maize
X Axis—$e^{7-r_m x} l_x m_x = 1096.6$
Y Axis—intrinsic rate of natural increase (r_m.)

o ..o Age-specific fecundity; ______Age-specific survival

Table 2 *The life-table (for females) and age-specific fecundity for* H. armigera *on sunflower and maize*

Host	Pivotal age in days	Survival of female at different age intervals	Age schedule for female births		
	X	l_x	m_x	$l_x m_x$	$l_x m_x X$
Sunflower	0—36	0.63	—	Immature stages	
	37	0.63		0.63	23.31
	38	0.63		0.63	23.94
	39	0.63		0.63	24.57
	40	0.63		0.63	25.20
	41	0.63	7.67	4.83	198.11
	42	0.63	39.67	24.99	1049.66
	43	0.63	85.25	53.70	2309.42
	44	0.63	113.50	71.50	3146.22
	45	0.63	139.90	88.13	3966.16
	46	0,63	91.76	57.80	2696.20
	47	0.63	55.60	34.96	1643.65
	48	0.61	31.30	10.09	916.46
	49	0.41	15 35	6 29	308.38
	50	0.32	15.00	4.80	240.00
	51	0.31	0.00	0.00	0.00
			$R_o = \sum l_x m_x = 368.61$		$\sum l^x m_x X = 16533.98$
Maize	0—36	0.60		Immature stages	
	37	0.60		0.60	22.20
	38	0.60		0.60	22.80
	39	0.60		0.60	23.40
	40	0.60		0.60	24.00
	41	0.60	7.13	4.27	175.07
	42	0.60	30.93	18.95	779.30
	43	0.60	86.93	52.15	2242.45
	44	0.60	101.43	60.85	2677.40
	45	0.60	82.51	49.50	2227.90
	46	0.60	55.90	33.64	1542.94
	47	0.60	32.00	19.20	902.40
	48	0.60	17.28	10.36	497.28
	49	0.37	9.50	3.51	171.99
	50	0.30	0.00	0.00	0.00
			$R_o = \sum l_x m_x = 254.33,$		$\sum l_x m_x X = 11308.4$

Table 3 *Mean length of generation, innate capacity for increase in numbers and finite rate of increase in numbers of* H. armigera *on sunflower and maize*

Host	Mean length of generation $T_c = \frac{\Sigma l_x m_x}{R_o}$	Innate capacity for increase in numbers $r_c = \frac{\log_e R_o}{T_c}$	Corrected r_m $\Sigma e^{7-r_m x} l_x m_x = 1096.6$ (per head/day)	Corrected generation time $T = \frac{\log_e R_o}{r_m}$	Finite rate of increasing in numbers $\lambda = \text{anti } e^{r_m}$	Weekly multiplication	Doubling time	Hypothetical F_2 females
Sunflower	44.85	0.1317	0.1328	44.50	1.1420	2.5334	5.22	1,35,873.33
Maize	44.46	0.1245	0.1257	44.06	1.1339	2.4106	5.51	64,633.74

generation was 44.50 days. The innate capacity (r_m) and finite rate (λ) for increase in numbers were 0.1328 and 1.1420 on sunflower and 0.1257 and 1.1339 females per female per day on maize, respectively. At this rate, the population of *H. armigera* was capable of multiplying 2.5334 times per week under the given set of conditions on sunflower. The hypothetical female population for both the hosts in F_2 generation respectively was 1,35,873.33 and 64,683.74. The observations were made on the contribution of respective stages towards stable age-distribution of *H. armigera* by calculating the population schedule of birth-rate and death-rate (m_x and l_x) (table 4). On reaching stable age-distribution, the populat ion of *H. armigera* in its various stages viz. egg, larva, pupa and adult contributed to the tune of 52.07, 43.27, 4.20 and 0.41 and 50.45, 44.40, 4.65, 0.49 per cent, on sunflower leaves and maize cobs, respectively.

Table 4 *Percentage contribution of various stages to the stable age-distribution of* H. armigera *on sunflower and maize*

Host	% Contribution of various stages			
	Egg	Larva	Pupa	Adult
Sunflower	52.07	43.27	4.20	0.41
Maize	50.45	44.40	4.65	0.49

Life-tables were prepared from daily fecundity and survival of *H. armigera* reared on lucerne, lima bean and pea. The intrinsic rates of natural increase (r_m) computed from these tables were 0.1160, 0.1070 and 0.1346 females per female per day (Bilapate et al. 1977, Bilapate et al. 1978, Bilapate & Pawar 1978). Scanty information is available on such type of calculation for individuals of an arthropod species. However, the innate capacity has been calculated for two species of noctuidae, the zebra caterpillar, *Ceramica picta* and the green cloverworm, *Plathypena scabra* (F.) (Tamaki et al. 1972, Wellik and Pedigo 1978). In the present experiment, the values of R_o, r_m and F_2 were superior to maize, hence sunflower proved to be nutritionally superior to maize host. It is important to remember that the value of r_m is limited by the biotic and physical factors that is tested or specified. The same could be used as bioclimatic index in assessing the pest potentialities of an insect introduced into a new area.

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