

## Investigations on *Heliothis armigera* (Hubner) in Marathwada. XXIII. Key Mortality Factors on Cotton, Pigeonpea and Chickpea

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*Camponotus chlorideae* Uchida was important mortality parameter in all the five generations of *H. armigera* on cotton followed by *Goniophthalmus halli* Mensil. There was decreasing trend in the population of *H. armigera* and the pest passed through three generations on pigeonpea. The pest multiplied for three generations and *C. chlorideae* was the most important mortality parameter in chickpea. The parasites, viz, *Enicospilus biconatus* Townes, Townes and Gupta (= *neorufus* Rao and Nikam), *Palexorista* sp. and *Eriborus argenteopilosus* Cameron were recorded from larvae collected on cotton and pigeonpea.

**Key Words :** *Heliothis armigera* (Hubner), Key mortality factors

### Introduction

The American cotton bollworm, *Heliothis armigera* (Hubner) is one of the major pests of cotton, pigeonpea, chickpea, sunflower and maize. During summer the pest population perpetuates on dhatura weed, okra and maize grown as fodder crop in this region. The present investigations deals with the study of key mortality factors of *H. armigera* on cotton, pigeonpea and chickpea during 1980-81.

### Materials and Methods

The materials and methods employed were similar to those used earlier (Bilapate et al.

1979, Bilapate 1981). The studies involved continual observations on the population of *H. armigera* in this region. The first appearance of eggs of *H. armigera* on cotton crop was observed on 5 July, 1980 and this was considered as the start of first generation of pest on cotton in monsoon season. The eggs from the samples were carefully separated and reared on respective hosts under laboratory condition. The sampling done for a generation in the field was based on the developmental stages reared in laboratory. The sample quadrates used were 2 × 2 m for all the crops and 5 such quadrates each in cotton and chickpea while 4 in pigeonpea were observed during

Table 1 Key mortality factors for the first, second and third generations of *H. armigera* on cotton during 1980

Age interval	1	2	3	4	5	6	7	8
X		Number alive at be- ginning of x lx	Factors responsible for dx dxF	Numbers dying during x dx	dx as a % of lx 100qx	Survival rate at age x Sx	Log (lx)	'k'
Expected eggs		2,100	FIRST GENERATION	100	4.76	0.95	3.3222	—
Viable eggs			Sterility/dead				3.3010	0.0212
<i>Larval instars:</i>								
I-II (N <sub>1</sub> )		2,000	<i>Chelonus</i>	166	8.30	0.92	3.3010	
III-IV		1,668	<i>Camptolepis</i>	166	9.05	0.91		
V-VI		1,335	Nematode	333	19.96	0.80	3.2222	0.0788
Pupae		1,335	—					
Moths		1,168	<i>Goniophthalmus</i>	167	12.51	0.87	3.1255	0.0967
Females × 2 (N <sub>3</sub> )		1,168	Sex 50% females				3.0674	0.0581
Trend index			(Reproducing females=584)	7.58			2.7664	0.3010
Generation survival				0.58				$\bar{K}=0.5538$
Expected eggs		16,077	SECOND GENERATION	910	5.66	0.94	4.2062	—
Viable eggs		15,167	Sterility/dead				4.1809	0.0253
<i>Larval instars:</i>								
I-II (N <sub>1</sub> )		15,167	<i>Chelonus</i>	500	3.30	0.97	4.1809	
III-IV		14,167	<i>Camptolepis</i>	500	3.41	0.96		
			<i>Eriborus</i>	333	2.35	0.98	4.1513	0.0296
			<i>Carcelia</i>	166	1.20	0.99		
			Unknown	166	1.21	0.99		

V-VI	13,502	<i>Carcelia</i>	333	2.47	0.97	4.1304	0.0239
		Virus	167	1.27	0.99		
		Unknown	500	3.84	0.96		
Pupae	12,502	<i>Goniophthalmus</i>	500	4.00	0.96	4.0970	0.0334
		Unknown	667	5.56	0.94		
Moths	11,335	Sex 50% females				4.0544	0.0426
Females × 2 (N <sub>3</sub> )	11,335	(Reproducing females=5,668)	1.64			3.7534	0.3010
Trend index			0.75				<u>K=0.4528</u>
Generation survival							

THIRD GENERATION

Expected eggs	26,000	Sterility/dead	1,000	3.85	0.96	4.4150	—
Viable eggs	25,000					4.3979	0.0171
<i>Larval instars:</i>							
I-II (N <sub>1</sub> )	25,000	<i>Campolepis</i>	3,666	14.66	0.85	4.3979	
III-IV	21,334	—					
V-VI	21,334	<i>Carcelia</i>	500	2.35	0.98	4.3291	0.0688
Pupae	20,834	<i>Goniophthalmus</i>	167	0.80	0.99	4.3188	0.0103
Moths	20,667	Sex 50% females				4.3153	0.0035
Females × 2 (N <sub>3</sub> )	20,667	(Reproducing females=10,334)	0.54			4.0143	0.3010
Trend index			0.83				<u>K=0.4007</u>
Generation survival							

Table 2 Key mortality factors for fourth and fifth generations of *H. armigera* on cotton during 1980-81

X	ix	dxF	dx	100qx	Sx	Log(ix)	'k'
FOURTH GENERATION							
Expected eggs	14,445		945	6.54	0.93	4.1597	—
Viable eggs	13,500					4.1303	0.0294
<i>Larval instars:</i>							
I-II (N <sub>1</sub> )	13,500	<i>Campolepis</i>	667	4.94	0.95	4.1303	
III-IV	12,833	—					
V-VI	12,833	<i>Carcelia</i>	333	2.59	0.97	4.1083	0.0220
		Virus	167	1.34	0.99		
		Unknown	333	2.70	0.97		
Pupae	12,000	<i>Goniophthalmus</i>	333	2.77	0.97	4.0792	0.0291
		Unknown	333	2.85	0.97		
Moths	11,334	Sex 50% females				4.0544	0.0248
Females × 2 (N <sub>2</sub> )	11,334	(Reproducing females=5,667)	0.79			3.7534	0.3010
Trend index			0.84				<u>K=0.4063</u>
Generation survival							
FIFTH GENERATION							
Expected eggs	11,520		853	7.40	0.92	4.0615	—
Viable eggs	10,667					4.0280	0.0335
<i>Larval instars:</i>							
I-II (N <sub>1</sub> )	10,667	<i>Campolepis</i>	333	3.12	0.97	4.0280	
III-IV	10,334	<i>Carcelia</i>	333	3.22	0.97	4.0143	0.0137
V-VI	10,001	<i>Carcelia</i>	167	1.67	0.98	4.0000	0.0143
		Unknown	167	1.70	0.98		
Pupae	9,667	<i>Goniophthalmus</i>	167	1.73	0.98	3.9853	0.0147
		Unknown	500	5.26	0.95		
Moths	9,000	Sex 50% females				3.9542	0.0311
Females × 2 (N <sub>2</sub> )	9,000	(Reproducing females=4,500)	0.00			3.6532	0.3010
Trend index			0.84				<u>K=0.4083</u>
Generation survival							

Table 3 Key mortality factors for the first, second and third generations of *H. armigera* on *pigeonpea* during 1980-81

X	lx	dxF	dx	100qx	Sx	Log(lx)	'k'
<b>FIRST GENERATION</b>							
Expected eggs	23,616		908	3.84	0.96	4.3732	—
Viable eggs	22,708	Sterility/dead				4.3562	0.0170
<i>Larval instars:</i>							
I-II (N <sub>1</sub> )	22,708	<i>Campolepis</i>	625	2.75	0.97	4.3562	
III-IV	22,083	<i>Carcelia</i>	417	1.89	0.98	4.3441	0.0121
V-VI	21,666	<i>Carcelia</i>	625	2.88	0.97	4.3358	0.0083
		Virus	625	2.97	0.97		
Pupae	20,416	<i>Goniophthalmus</i>	417	2.04	0.98	4.3100	0.0258
		Unknown	208	1.04	0.99		
Moths	19,791	Sex 50% females				4.2965	0.0155
Females × 2 (N <sub>2</sub> )	19,791	(Reproducing females = 9,895)				3.9954	0.3011
Trend index			0.83				<u>K = 0.3778</u>
Generation survival			0.87				
<b>SECOND GENERATION</b>							
Expected eggs	19,906	Sterility/dead	948	4.76	0.95	4.2990	—
Viable eggs	18,958					4.2778	0.0212
<i>Larval instars:</i>							
I-II (N <sub>1</sub> )	18,958	<i>Campolepis</i>	624	3.29	0.97	4.2778	
III-IV	18,334	<i>Carcelia</i>	416	2.27	0.98	4.2633	0.0145
V-VI	17,918	<i>Carcelia</i>	417	2.33	0.97	4.2533	0.0100
		Unknown	208	1.20	0.99		
Pupae	17,293	<i>Goniophthalmus</i>	625	3.61	0.96	4.2379	0.0154
		Unknown	416	2.49	0.97		
Moths	16,252	Sex 50% females				4.2109	0.0270
Females × 2 (N <sub>2</sub> )	16,252	(Reproducing females = 8,126)				3.9099	0.3010
Trend index			0.41				<u>K = 0.3891</u>
Generation survival			0.86				

Table 1 (Contd.)

X	lx	dx	100qx	Sx	Log(lx)	'k'
THIRD GENERATION						
Expected eggs	8,248	540	6.55	0.93	3.9163	—
Viable eggs	7,708				3.8869	0.0294
<i>Larval instars:</i>						
I-II (N <sub>1</sub> )	7,708	208	2.70	0.97	3.8869	
III-IV	7,500	416	5.55	0.94	3.8751	0.0118
V-VI	7,084	416	5.87	0.94	3.8503	0.0248
		208	3.12	0.97		
Pupae	6,252	208	3.22	0.97	3.7960	0.0543
		208	3.33	0.97		
Moths	5,836	208	3.44	0.96	3.7661	0.0299
Females × 2 (N <sub>0</sub> )	5,836				3.4651	0.3010
Trend index		0.00				$K=0.4512$
Generation survival		0.75				

Table 4 Key mortality factors for first, second and third generation of *H. armigera* on chickpea during 1980-81

X	lx	dxF	dx	100qx	Sx	Log(lx)	'k'
<b>FIRST GENERATION</b>							
Expected eggs	29,870		870	2.91	0.97	4.4752	—
Viable eggs	29,000					4.4624	0.0128
<i>Larval instars:</i>							
I-II (N <sub>1</sub> )	29,000		3,666	12.64	0.87	4.4624	
III-IV	25,334		333	1.31	0.99	4.4037	0.0587
V-VI	25,001		333	1.33	0.99	4.3980	0.0057
Pupae	24,668		667	2.70	0.97	4.3921	0.0059
Moths	23,668		333	1.39	0.99		
Females × 2 (N <sub>2</sub> )	23,668					4.3742	0.0179
Trend index						4.0731	0.3011
Generation survival			0.60				<u>K=0.4021</u>
			0.82				
<b>SECOND GENERATION</b>							
Expected eggs	18,373		1,040	5.66	0.94	4.2642	—
Viable eggs	17,333					4.2389	0.0253
<i>Larval instars:</i>							
I-II (N <sub>1</sub> )	17,333		3,499	20.19	0.80	4.2389	
III-IV	13,834		1,666	12.04	0.88	4.1409	0.0980
V-VI	12,168		166	1.36	0.99	4.0852	0.0557
Pupae	11,502		500	4.17	0.96		
Moths	9,836		1,166	10.14	0.90	4.0608	0.0244
Females × 2 (N <sub>2</sub> )	9,836		500	4.84	0.95		
Trend index						3.9928	0.0680
Generation survival			0.43			3.6918	0.3010
			0.57				<u>K=0.5724</u>

Table 4 (Contd.)

X	lx	dxF	dx	100qx	Sx	Log(lx)	'k'
THIRD GENERATION							
Expected eggs	8,025	Sterility/dead	525	6.54	0.93	3.9044	—
Viable eggs	7,500					3.8751	0.0293
Larval instars:							
I-II (N <sub>1</sub> )	7,500	<i>Campoletis</i>	1,000	13.33	0.87	3.8751	
III-IV	6,500	<i>Carcellia</i>	333	5.12	0.95	3.8129	0.0622
V-VI	6,167	Unknown	333	5.40	0.95	3.7901	0.0228
Pupae	5,834	<i>Goniophthalmus</i>	333	5.71	0.94	3.7660	0.0241
Moths	5,501	Sex 50% females				3.7404	0.0256
Females × 2 (N <sub>2</sub> )	5,501	(Reproducing females=2,751)	0.00			3.4395	0.3009
Trend index			0.73				$\frac{0.3009}{K=0.4649}$
Generation survival							



subsequent observations based on laboratory culture. The data on the number of parasites were recorded for each sample. The column headings used in this studies were as proposed by Morris and Miller (1954).

### Results and Discussion

The results obtained for the key mortality factors of *H. armigera* for respective generations on cotton are presented in tables 1 and 2. The parasitisation of larvae of *H. armigera* in first generation, because of *Chelonus* sp., *Campoletis chlorideae* Uchida and nematode (identification awaited) was 8.30, 9.05 and 19.96%, respectively. The % parasitisation of pupae because of *Goniophthalmus halli* Mensil was 12.51. During the second generation, there was 2.35 and 2.47% parasitisation because of *Eriborus argenteopilosus* Cameron and *Carcelia* sp. The *C. chlorideae* was only the dominant parasite (14.66%) in third generation. The % parasitisation due to *C. chlorideae* was 4.94 and 3.12 in fourth and fifth generations (table 2). The parasitisation on pigeonpea because of *C. chlorideae* and *Carcelia* sp. was 2.75 (I-II), 1.89 (III-IV) and 2.88% (V-VI), respectively (table 3). The same was 3.29 (I-II), 2.27 (III-IV) and 2.33% (V-VI), respectively during the second generation. The mortality of the pest in pupal stage, because of *G. halli* and unknown reasons, was 3.33 and 3.44% in third generation on pigeonpea. The generation survival was 0.82, and the negative trend index value of 0.60 indicated reduction in the pest population on chickpea in second generation (table 4). The parasitisation of *H. armigera* was 20.19% in second generation and the major contributing factor towards the pupal mortality was *G. halli* resulting in 10.14% parasitisation. The mortality of *H. armigera* in III-IV and V-VI instars was 5.12 and 5.40% because of *Carcelia* sp. and unknown reasons in third generation on chickpea.

*C. chlorideae* alone was important mortality parameter operating during the five genera-

tions of *H. armigera* on cotton followed by *G. halli*. The *Chelonus* sp. was recorded to the extent of 8.30 and 3.30% only during the first two generations on cotton. The % parasitisation because of *Carcelia* sp. did not exceed 4.89 on cotton. There was increasing trend in the population of *H. armigera* up to third generation, and thereafter it declined. The two larval parasites viz. *C. chlorideae* and *Carcelia* sp. and *G. halli* as pupal parasite, were reared when larvae collected on pigeonpea. There was decreasing trend of pest population in all the three generations on pigeonpea. *C. chlorideae*, *Carcelia* and *G. halli* helped to check the population of *H. armigera* on chickpea and all the three parasites comparatively yielded noticeable % parasitisation than cotton and pigeon pea. According to Bilapate *et al.* (1979), a larval parasite, *C. chlorideae* was alone responsible for reducing the population of *H. armigera* on chickpea (24.92%) during winter season. *H. armigera* has a wide range of host plants but infestation is largely restricted to one stage in the host development (Hardwick 1965). Roome (1971) stated that the peak of oviposition occurs before anthesis in jowar and eggs are laid mainly on the compact young flower heads as it emerges from the flag leaf. In Orissa, *H. armigera* passes through 4 to 6 generations (Sen Gupta & Behura 1957). About 8 generations were reported in a year with hibernation as pupa (Beeson 1961). According to Singh and Singh (1975), all the stages of pest were available from March to May in Punjab. Further they reported that the pest become inactive in June due to high temperatures and rested in the soil in caterpillar or pupal stage and this has four generations on different crops.

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