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Moth emergence pattern of *Helicoverpa armigera* (Hübner) (Lepidoptera: Noctuidae) in cotton ecosystem

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ABSTRACT

Studies on moth emergence pattern of *Helicoverpa armigera* (Hübner) in the cotton ecosystem indicated that on an average 60.31 to 73.73 per cent moths emerged during different weeks. From the pupae formed during 46th standard week (i.e. during November) two moths emerged after 109 and 115 days of pupation, indicating the presence of winter pupal diapause. Rate of moth emergence increased after the rains when mean relative humidity reached around 70 per cent and mean temperature around 27°C.

A species breeds successfully when environmental conditions are favourable. This is true particularly with poikilothermic organisms such as *Helicoverpa armigera* (Hübner) (Lepidoptera: Noctuidae), which is a polyphagous pest of many economically important crops. The pest status of *Helicoverpa* is related to its physiological, behavioral and ecological characteristics which help in its perpetuation. Polyphagy, high mobility, facultative diapause and high fecundity enable it to survive adverse conditions (Fitt, 1989). Owing to high fecundity, even a small proportion of adult emergence could contribute significantly to initial population build up. Thus, studies on moth emergence pattern of this pest may help in predicting future population trends.

MATERIALS AND METHODS

The experiment was conducted in the Research Farm of the Department of Entomology, Chaudhary Charan Singh Haryana Agricultural University, Hisar (29° 10' N, 75° 46'E, 215.2 m m.s.l.), Haryana, India during cotton crop seasons of 2003 and 2004. For recording adult emergence pattern during different months of cotton crop season, the larvae were allowed to pupate under near natural field conditions. For this purpose, grown up larvae were collected from cotton fields and from other hosts during off-season and further reared on the same host until full grown. These were released individually in perforated plastic specimen tubes (10x4.5cm) and fixed in soil in the field as described by Saini and Olla (2004). Before placing in the field such tubes were first filled with moist field soil up to the 3/4th capacity and one full grown larva was placed over the soil in the tube. After the larva entered the soil, these tubes were numbered and fixed in the cotton field. These tubes were kept under daily observation to record adult emergence. There were three different sets of experiment i.e. one each during crop season of 2003 and 2004 and one during April to May, 2004. For pupae kept during crop seasons of 2003 (1st year) and 2004 (2nd year) observations for adult emergence were taken till third week of March of the following year after which these were dug out to record number of dead pupae. Pupae kept during April-May 2004 were dug out after the 25th week to record their survival since there was no emergence after the 22nd week. In all, 270 and 309 pupae were placed in 2003 and 2004, respectively in the field during different months. Adult emergence was correlated with temperature, relative humidity and rainfall.

RESULTS AND DISCUSSION

i) Moth emergence during 1st year: Data on emergence pattern of *H. armigera* moths during different standard weeks are presented in Table 1. Moth emergence continued throughout the crop season. However, rate of moth emergence varied at

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different periods of the crop season. On the basis of observation of 270 pupae during the season, moth emergence ranged from 28.57 to 90.90 per cent with a mean emergence of 73.33 per cent. Emergence was 80 per cent or more during 38th, 40th, 42nd and 48th week, being maximum (90.9%) during 42nd week. Moth emergence from pupae kept during 37th to 39th week finished within two weeks. However, as the season advanced and temperature gradually declined, moth emergence was spread over several weeks. It was spread over 8 weeks in the case of pupae placed in the field during 48th week. Since population declined sharply after 45th week, fewer pupae could be placed in the field later on. In response to rains during 37th and 39th week resulting in higher mean relative humidity of 69.4 per cent (64.5-76.0%) together with a mean temperature of 26.9°C (24.3-29.8°C) during the 37th to 41st standard week, an increased moth emergence was observed during the 38th to 42nd standard week. Out of 145 pupae placed during this period, 107 (i.e. 73.79%) moths emerged within the first two weeks of pupation. After 45th week, when the mean temperature dropped below 22°C the period of moth emergence was spread over 6 week and one of the moths from pupa formed in 48th week emerged in 11th week after more than 105 days in pupal stage. This indicates that a proportion of population undergoes winter pupal diapause.

ii) Moth emergence during 2nd year : Moth emergence from the pupae kept in the field during the summer months (April-May) was poor. Out of a total of 115 pupae, only 14 (i.e. 12.17%) yielded moths (Table 2). The emergence of adults started about 12 days after pupae were placed in the field. There was not much variation in the rate of emergence as all the moths emerged within 11-13 days after pupation. On the other hand moth emergence during the crop season started in the following two to four weeks after the placement of pupae in the field during 38th to 41st week, except for two pupae placed in 39th week, which took 4 and 7 weeks. In response to rains in 39th and 40th week resulting in mean relative humidity of 68.1 per cent (60.0-73.0%) and mean temperature 26.8°C (24.7-28.1°C), increased moth emergence was observed during 40th to 43rd week. During 45th and 46th week when mean temperature dropped to 18.3 and 19.6°C, respectively, the period of moth emergence was spread over 6 weeks, except two moths which emerged after 109 and 115 days, indicating the presence of winter diapause in a portion of the population. Out of a total of 194 pupae kept in the field, 60.31 per cent were able to yield moths. About 53 per cent moths emerged within 2-4 weeks of pupation in the case of pupae placed during 38th to 42nd standard week when the mean temp. was 26.2°C (23.5-28.1°C) and mean r.h. 66.3 per cent (69-73%).

Moths of *H. armigera* continued to emerge throughout the year, though the rate of emergence was variable during different standard weeks. Moth emergence was quicker in summer months and spread over several weeks during winter months of the year. Variability in pattern of moth emergence in field populations of *H. armigera* has earlier been reported by several workers (Komarova and Kuznetsova, 1971; Kuznetsova, 1972; Wilson, Lewis, and Cunningham, 1979; Chaudhary and Sharma, 1981; Olla, 1998; Saini and Olla, 2004).

Rains resulting in relative humidity ≅ 70 per cent appeared to have a stimulatory effect on moth emergence. For example, it rained during 39th and 40th standard week of 1st year and 2nd year, respectively and correspondingly a good number of moths emerged within the same week or following weeks. Saini and Olla (2004) also observed stimulatory effect of rains on moth emergence in *H. armigera*. Earlier, *H. armigera* larvae were observed on cotton as early as in the first week of July, and a few even during June, when good rains occurred during May, and there was heavy population build-up during August-September (Anonymous, 2001). Saini, Jaglan, and Naresh (2004) concluded that *H. armigera* incidence was relatively more in years having higher and frequent rains. Though, little information on the direct effect of rainfall on *H. armigera* population is available, yet rainfall is reported to indirectly influence seasonal abundance of the pest by affecting the abundance and suitability of host plants (Fitt, 1989). Rains during summers were particularly important in making the environmental conditions less harsh for survival of this pest and a greater number of individuals could be carried over to the next generation under such a situation. On the other hand, Tripathi and Singh (1993) reported that rainfall had an inverse relationship with the moth emergence. In the present studies, 2.24 to 27.27 per cent adults were found trapped in emergence tunnels

Table 1. Emergence pattern of *H. armigera* moths (1st year).

SW of pupation	Month	Pupae kept (No.)	Mean temp. (°C)	Mean R.H. (%)	Rainfall (mm)	Number of moths emerged during different standard weeks (SW)																										Total	% emergence
						Standard week of moth emergence																											
						38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	01	02	03	04	05	06	07	08	09	10	11		
37	Sep.	13	28.7	76.0	2.2	7																										7	53.84
38		30	29.8	69.5	0.0		21	3																								24	80.00
39		10	27.0	73.0	23.0			3																								3	30.00
40	Oct	54	24.7	64.0	0.0				20	28																						48	88.88
41		38	24.3	64.5	0.0					7	18	1																				26	68.42
42		55	22.9	58.0	0.0						6	29	15																			50	90.90
43		22	22.6	59.5	0.0								13	2	1																	16	72.72
44		11	21.2	60.0	0.0								1	0	3	0	2															6	54.54
45	Nov	21	21.5	51.0	0.0												3	2	0	0	0	1										6	28.57
48		5	13.4	60.5	0.0																			2	1	0	0	0	0	0	1	4	80.00
49*	Dec	11	16.7	61.0	0.0																		1	5	1	1						8	72.72
Total		**270**				**7**	**21**	**6**	**20**	**35**	**24**	**30**	**29**	**2**	**4**	**0**	**5**	**2**	**0**	**0**	**0**	**1**	**1**	**7**	**2**	**1**	**0**	**0**	**0**	**0**	**1**	**198**	**73.33****

*The experiment was terminated and the remaining pupae were dug out in the third week of March, 2004

**Mean

Table 2. Emergence pattern of *H. armigera* moths (2nd year).

SW of pupation	Month	Pupae kept (No.)	Mean temp. (°C)	Mean R.H. (%)	Rainfall (mm)	Number of moths emerged during different standard weeks (SW)																						Total	% emergence
						Standard week of moth emergence																							
						15	16	17	18	19	20	21	22.....40	41	42	43	44	45	46	47	48	49	50	51.....9	10				
14	Apr	19	27.7	43.0	0.0	1	1																					2	10.52
15		34	29.1	31.5	0.0		2	5																				7	20.60
16		20	30.8	37.0	0.0			1																				1	5.00
17		7	29.0	48.0	0.0																							0	0.00
18	May	13	25.0	63.0	43.2					1																		1	7.00
21*		22	32.5	51.0	23.2								3															3	7.70
Total		**115**				**1**	**3**	**6**	**0**	**1**	**0**	**0**	**3**															**14**	**12.17****
38	Sept	30	28.1	70.5	0.0									22	2													24	80.00
39		51	27.7	60.0	3.0									12	11	0	1	0	0	1								25	49.00
40	Oct	10	27.0	73.0	28.4											3	1											4	40.00
41		37	24.7	69.0	8.0											1	12	5										18	48.64
42		10	23.5	59.0	0.0													2	7	1								10	100.0
43		11	21.5	59.5	0.0														4	3								7	63.63
44		9	19.0	61.0	0.0															1	3	1						5	55.55
45	Nov	18	18.3	60.0	0.0																1	5	1	1	2			10	55.55
46*		18	19.6	57.5	0.0																		4	6	2		1	14	77.77
Total		**194**												**34**	**13**	**4**	**14**	**7**	**11**	**6**	**4**	**6**	**5**	**7**	**4**		**1**	**117**	**60.31****

*The experiment was terminated and the remaining purpae were dug out in the third week of June, 2004 for which pupae kept during April-May, 2004; and in third week of March, 2005 for which pupae kept during September-November, 2004.

**Mean

(data not shown). This might probably be due to formation of soil crust on the surface or clogging of emergence tunnel by rains, irrigation or other factors. Tripathi and Sharma (1985) reported that heavy rainfall tended to break down pupal chambers in soil preventing moth emergence. Likewise, Murray and Zalucki (1990) reported that simulated rainfall after pupation, but before moth emergence, reduced survival of *H. armigera* by disrupting emergence tunnels and trapping moths in the tunnels.

Two-year studies indicated that under the agro-climatic conditions of Haryana about 70 per cent moths of *H. armigera* emerged from the pupae during the cotton crop season. However, during the summer months (April-May), there was heavy mortality of pupae and moth emergence was about 12 per cent only. Rains had a positive effect on moth emergence as rate of moth emergence was higher after the rains. Therefore, in years of moderate summers and high rains/r.h. higher incidence of this pest is expected on the crop.

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