Research Article

Monitoring cotton bollworms through synthetic sex pheromone traps

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Abstract

Bollworms are most serious pests of cotton crop which do not only cause losses by devouring foliage and fruiting bodies of cotton which results in low yield but also deteriorate its lint quality. Their management relies on application of pesticides but recent introduction of synthetic pheromones for mass trapping of their adult moths have given better solution for recording and monitoring their population. We used five different components of synthetic sex pheromone installed in funnel type traps (4 traps/per acre) at different localities of district Sanghar. The components were (0E, 12E)-10, 12 Hexadecadienal for *Earias insulana* (Boisduval), Z7, Z11-16AC (50), Z7, E11-16AC (50) Hexadecadienyle Acetate for *Pectinophora gossypiella* (Saunders), D, Z11-16AL (97), Z9-16 AL (3) Hexadecenal for *Helicoverpa armigera* (Hubner) and (Z, E)-9,11- and (Z, E)-9, 12-tetradecadienyl acetate (Z9, E11-14: Ac; Z9, E12-14: Ac) for *Spodoptera litura* (Fabricius). All these bollworm species in different localities were successfully trapped with significant different population. A maximum population of *P. gossypiella* and *H. armigera* were at Tando Adam, *E. insulana* at Shadadpur and *S. litura* at Jam Nawaz Ali. *P. gossypiella* trapped maximal in the month of October, *E. insulana* in September, *H. armigera* in August and *S. litura* in November, respectively. Based on the results, it is recommended that these pheromone lures should be introduced at different timings and pest species according to their presence.

Keywords: Cotton; Bollworms; Population; Sex pheromone

Introduction

Cotton *Gossypium hirsutum* L. is one of the important cash crops grown in Pakistan. It contributes substantially (1.4%) to the national economy and possess a primary source of livelihood for rural people [1]. During the current year 2018, cotton production was 9.86 million bales, with a decrease of 17.5 percent over the production of 2017 (11.946 million bales).

This below expectation performance of the cotton crop was largely due to reduction in the cultivated area on account of less economic incentive given to the farmers [2]. There are number of factors responsible for lower cotton yield but insects are ranked at the top, which do not only deteriorate the quality of cotton but also reduce the yields [3]. Cotton crop is mostly attacked by the insect pests from seedling to

harvesting but the maximum losses (30-40%) are recorded by bollworms [4]. In bollworms, army worm *Spodoptera litura* (Fabricius), spotted bollworm *Earias insulana* (Fabricius), american bollworm *Helicoverpa armigera* (Hubner) and pink bollworm *Pectinophora gossypiella* (Saunders) are the major pests of cotton crop [5]. Among these bollworms, *P. gossypiella* is the most serious pest because it damages the reproductive part of crop during immature stage (larvae), remains inside bolls and very difficult to control with by insecticides. The pest is widely distributed all over the world particularly in India and Pakistan. The other two species of bollworms tend to cause more conspicuous damage particularly to the newly developing fruiting bodies and the terminal shoots. Meanwhile, these bollworms badly affect the quantity and quality of the lint. Control of these pest species with conventional insecticides is very difficult due to high cost and inaccessibility [6]. The use of sex pheromone lures for insect monitoring and reducing their population by adult moth trapping nowadays is the common practice by various cotton research institutes of Pakistan. Some progressive growers are also well familiar with application of different pheromones in cotton crop, as these are inexpensive and eco-friendly strategy in integrated pest management tools [7]. Since few years, it has been well documented that synthetic pheromones are better to monitor and

control the cotton bollworms population as compared to other control measures [8]. In Sindh province, few studies regarding use of pheromone have been previously conducted [9], but there is still lack of studies conducted in district Sanghar, which is to be considered as hub of cotton growing and processing area of Sindh province. Therefore, the aim of present experiment was designed to observe the population of cotton bollworms through synthetic sex pheromone traps in the various locations of district Sanghar, Sindh, Pakistan.

Materials and methods

The study was conducted at four localities of district Sanghar i.e., Tando Adam, Shahdadpur, Jam Nawaz Ali and Sinjhor. In each locality, 4 traps/ acre with four replications were selected for different bollworm species. There were no application of pesticide was applied throughout the study. The synthetic sex pheromone lures were (0E, 12E)-10, 12 Hexadecadienal for *E. insulana*, Z7 Z11 – 16AC (50), Z7 E11 – 16AC (50) Hexadecadienyle Acetate for *P. gossypiella*, D. Z11-16AL (97), Z9 -16 AL (3) Hexadecenal for *H. armeigera* and (Z,E)-9,11- and (Z,E)-9,12-tetradecadienyl acetate (Z9, E11-14: Ac; Z9, E12-14: Ac) for *S. litura*. These lures were installed in funnel type traps and fixed at 1 foot above the crop level in 7-shaped structure wooden frame (Fig. 1). We followed the procedure as described previously [10].

Figure 1. Funnel type pheromone trap

The synthetic sex pheromone traps for each species were replaced after every 15 days and data were recorded fortnightly. Trapped adults were brought and counted in separate Petri dishes (11x15 mm).

Data analysis

The experiment was laid out in Randomized Complete Block Design (RCBD) with four treatments and four replications. The data were subjected to analysis by using ANOVA statistical test and the means were separated by using Fisher's Least Significant Difference (LSD) at 5% level. All the statistical tests were done by using SAS (Ver. 9.2).

Results and discussion

The population of *P. gossypiella* in different localities were significantly different (DF=3; F=11.76; $P < 0.05$). The highest mean population was 8.49 ± 0.26 at Tando Adam followed by 8.26 ± 0.22 at Shahdadpur with non-significant difference and the lowest was 4.87 ± 0.19 at Sinjhor followed by 5.17 ± 0.14 at Jam Nawaz Ali also with non-significant difference. However, the collective weekly population of *P. gossypiella* at all localities was highest (31.65 ± 3.1) in the second week of October (Table 1).

The population of *H. armigera* were non-significantly different at different localities (DF=3; F=5.09; $P > 0.05$). The maximum population of *H. armigera* was 0.91 ± 0.09 at Tando Adam followed by 0.82 ± 0.05 at Sinjhor, 0.72 ± 0.03 at Shahdadpur and minimum 0.68 ± 0.11 at Jam Nawaz Ali. The collective weekly population of *H. armigera* at all localities was highest (6.42 ± 0.23) in the last week of August (Table 2).

The population of *E. insulana* were non-significantly different at different localities (DF=3; F=5.09; $P > 0.05$). The maximum population of *E. insulana* was 1.77 ± 0.15 at Shahdadpur followed by 1.70 ± 0.13 at Jam Nawaz Ali, 1.62 ± 0.13 at Tando Adam, and 1.42 ± 0.11 at Sinjhor. The collective weekly population of *E. insulana* at all localities was highest (9.37 ± 1.09) in the third week of September as in (Table 3).

The population of *S. litura* in different localities were non-significantly different (DF=3; F=6.09; $P > 0.05$). The highest mean population was 2.46 ± 0.89 at Jam Nawaz Ali followed by 2.11 ± 0.73 at Tando Adam, 2.06 ± 0.31 at Sinjhor and 1.98 ± 0.21 at Shahdadpur. However, the collective weekly population of *S. litura* at all localities was highest (10.24 ± 1.31) in the first week of November (Table 4).

The results of sex pheromone traps in (Fig. 2 & Table 5), showed that the adult population of bollworms was varied at the different localities. The results showed that the maximum number of adults were collected from Tando Adam, followed by Shahdadpur, Jam Nawaz Ali, and Sinjhor. Comparison between adult species and the maximum number of *P. gossypiella* adults were trapped as compared to *S. litura*, *E. insulana*, and *H. armigera*.

The population of *P. gossypiella* was correlated with abiotic factors, that it showed positive correlation ($r = 0.812$, $p < 0.05$) with highly significant difference with temperature and relative humidity was significantly different (0.69, $p < 0.05$) and further showed non-significant different (0.52, $p > 0.05$) with dates. The population of *E. insulana* was correlated with abiotic factors, that it showed positive correlation ($r = 0.50$, $p < 0.05$) with lowest significant difference with temperature and relative humidity was lowest significantly different (0.49, $p < 0.05$) and further showed non-significant different (0.49, $p > 0.05$) with dates. The population of *S. litura* was correlated with abiotic factors, that it showed positive correlation ($r = 0.63$, $p < 0.05$) with lowest significant difference with temperature and relative humidity was lowest significantly different (0.55, $p < 0.05$) and further showed non-significant different (0.51, $p > 0.05$) with dates. The population of *H. armigera* was correlated with abiotic factors, that it showed positive correlation ($r = 0.51$, $p < 0.05$) with lowest

significant difference with temperature and relative humidity was lowest significantly different (0.48, $p < 0.05$) and further showed non-significant different (0.50, $p > 0.05$) with dates.

Bollworms, *H. armigera*, *P. gossypiella*, *E. insulana* and *S. litura* are major pests of cotton [11]. Present results are in agreement with [12-14] who indicated that sex pheromones proved more effective for monitoring the adult moth of bollworms. *P. gossypiella* was very attractant to sex pheromones as compared to other bollworms [15, 16]. Present results supported the findings of [17-19] who also

reported that maximum population of Pink bollworm was observed during October. [20] recorded highest population of *E. insulana* in the month of September, whereas large numbers of *H. armigera* were recorded during the month of August to September. Some other researchers observed with little difference and reported; [21] used sex pheromones for control of bollworm in Multan (Pakistan), according to him maximum population of adult moths were recorded in the month of September and October and minimum in the month of June, [22, 23] have also presented similar results. [24] Also had same observation for bollworm species in Sindh.

Table 1. Weekly adult population (Mean±S.E) of *P. gossypiella* at different localities of district Sanghar (2018)

Dates	Adult population				
	<i>P. gossypiella</i>				Grand total
	Shahdadpur	Tando Adam	Sinjhoro	Jam Nawaz Ali	
14/08/18	8.66	8.00	2.33	4.33	23.32 ±0.9bc
21/08/18	9.21	8.33	3.66	4.09	25.65 ±1.2b
28/08/18	7.61	9.66	4.66	4.32	25.98 ±1.1b
04/09/18	9.09	9.33	4.33	4.09	26.66 ±0.4b
11/09/18	8.45	8.66	4.66	3.66	25.64 ±1.1b
18/09/18	8.34	8.66	6.78	5.33	29.1 ±2.9a
25/09/18	8.66	9.09	4.33	5.66	27.65 ±1.8b
02/10/18	8.56	9.01	4.33	4.66	26.65 ±0.5b
09/10/18	8.38	10.01	4.66	7.66	31.65 ±3.1a
16/10/18	9.21	9.01	5.34	6.57	29.57 ±2.8a
23/10/18	6.68	8.21	5.66	6.32	26.64 ±0.6b
01/11/18	6.66	8.33	6.66	8.66	30.31 ±2.8a
06/11/18	8.06	10.66	6.66	6.33	30.65 ±2.9a
13/11/18	7.33	6.33	4.66	3.00	21.32 ±0.6c
20/11/18	8.66	4.33	4.61	3.33	20.93±0.4cd
	8.26±0.22a	8.49±0.26a	4.87±0.19b	5.17±0.14b	

Table 2. Weekly adult population (Mean±S.E) of *H. armigera* attracted to sex pheromone traps

Dates	Adult population				
	<i>H. armigera</i>				Grand total
	Shahdadpur	Tando Adam	Sinjhoro	Jam Nawaz Ali	
14/08/18	0.96	0.02	1.11	1.15	3.24±0.09bc
21/08/18	0.99	1.05	1.33	1.35	4.72±0.12b
28/08/18	1.37	1.06	1.9	2.09	6.42±0.23a
04/09/18	1.66	0.06	0.93	1.93	4.58±0.03b
11/09/18	1.08	1.54	0.26	0.26	3.14±0.54bc

18/09/18	0.38	1.63	1.55	0.55	4.11±0.32b
25/09/18	0.66	1.00	0.69	0.69	3.04±0.07bc
02/10/18	0.22	1.29	0.81	0.11	2.43±0.12c
09/10/18	0.61	0.98	0.51	0.11	2.21±0.09c
16/10/18	0.91	1.02	0.85	0.15	2.93±0.13c
23/10/18	0.24	1.02	0.11	0.13	1.5±0.05c
01/11/18	0.35	1.05	0.33	0.17	1.9±0.04c
06/11/18	0.21	0.13	0.23	0.18	0.75±0.05d
13/11/18	0.96	0.20	1.11	0.90	2.24±0.25c
20/11/18	0.99	0.50	0.33	1.35	1.72±0.11c
	0.72±0.03a	0.91±0.09a	0.82±0.05a	0.68±0.01a	

Table 3. Weekly adult population (Mean±S.E) of *E. insulana* attracted to sex pheromone traps

Dates	Adult population				Grand total
	<i>E. insulana</i>				
	Shahdadpur	Tando Adam	Sinjhoro	Jam Nawaz Ali	
14/08/18	1.16	1.12	0.16	1.05	3.49±0.31d
21/08/18	1.19	1.25	1.36	1.31	5.11±1.12c
28/08/18	1.17	1.16	1.09	1.01	4.43±0.98cd
04/09/18	1.26	1.34	1.43	1.13	5.16±1.10c
11/09/18	3.18	2.21	1.16	2.26	8.81±2.10a
18/09/18	3.38	2.33	1.51	2.15	9.37±1.09a
25/09/18	2.66	2.04	2.19	2.16	9.05±1.23a
02/10/18	2.12	2.89	1.51	2.31	8.83±1.21a
09/10/18	1.61	2.18	2.13	2.04	7.96±1.08b
16/10/18	1.91	2.02	2.18	2.13	8.24±0.99a
23/10/18	1.43	1.32	1.21	2.15	6.11±0.98b
01/11/18	1.11	1.13	1.31	1.17	4.72±0.67cd
06/11/18	0.79	0.13	1.21	1.18	3.31±0.21d
13/11/18	1.16	1.12	0.16	1.05	3.49±0.11d
20/11/18	0.90	1.00	0.36	1.31	2.11±0.21d
	1.77±0.15a	1.62±0.13a	1.42±0.11a	1.70±0.13a	

Table 4. Weekly adult population (Mean±S.E) of *S. litura* attracted to sex pheromone traps

Dates	Adult population				Grand total
	S. litura				
	Shahdadpur	Tando Adam	Sinjhoro	Jam Nawaz Ali	
14/08/18	2.14	2.12	2.14	2.15	8.55±1.21b
21/08/18	2.11	2.21	2.78	2.71	9.81±1.29a
28/08/18	2.17	2.11	1.19	2.91	8.38±1.09b
04/09/18	2.26	3.14	1.13	2.73	9.26±1.09a
11/09/18	1.18	2.21	2.16	1.16	6.71±0.13c
18/09/18	1.18	1.13	2.51	1.75	6.57±0.05c
25/09/18	1.36	1.45	2.89	3.06	8.76±0.95b
02/10/18	3.19	1.69	2.27	2.61	9.76±0.89a
09/10/18	2.31	1.16	1.19	2.34	7.00±0.23c
16/10/18	1.21	2.42	1.17	1.19	5.99±0.52c
23/10/18	2.13	2.38	2.41	2.65	9.57±1.09a

01/11/18	2.11	3.10	2.11	2.47	9.79±1.07a
06/11/18	2.12	2.23	2.71	3.18	10.24±1.31a
13/11/18	2.14	2.12	1.97	3.09	9.32±1.07a
20/11/18	2.15	2.15	2.25	2.97	9.52±1.17a
	1.98±0.21a	2.11±0.73a	2.06±0.31a	2.46±0.89a

Figure 2. Mean population of cotton bollworms attracted from different locations at district Sanghar

Table 5. Correlation coefficient measured between population of bollworms and environmental factors

Bollworms species	Temperature (°C)	Relative Humidity (%)	Dates (Weekly)
<i>Pectinophora gossypiella</i>	0.812**H.S	0.69*S	0.52*N.S
<i>Earias insulana</i>	0.50*S	0.49*S	0.49*N.S
<i>Spodoptera litura</i>	0.63**S	0.55*S	0.51*N.S
<i>Helicoverpa armigera</i>	0.51*S	0.48*S	0.50*N.S

Conclusion

On the basis of present research work on monitoring the adult population of cotton bollworms through synthetic sex pheromone traps it has been concluded that the highest population of *P. gossypiella* and *H. armigera* were found in Tando Adam, *E. insulana* was found in Shadadpur, and *S. litura* was found in Jam Nawz Ali.

Authors' contributions

Conceived and Performed the experiments: GN Sehto, IA Rajput, MM Kolachi, RAK Laghari, Designed the experiments: AM Ahmed, Provided lures: AK Pathan, Data analysis: MS Depar & B Mal. Wrote the paper: IA Rajput.

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