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Research Article

Estimating the potential of various harboring sites of Pink Bollworm (*Pectinophora gossypiella*) in relation to Environmental factors

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ABSTRACT

***Pectinophora gossypiella* is the most potential pest among all bollworms of cotton crop. Studies were conducted to find the Pink Bollworm (PBW) moths population in pheromone traps installed near different harboring sites. Pink Bollworm larvae overwinter in cotton seeds or in soil. From these sources moth emerges, that affect the next season crop. The sex pheromone traps charged with Gossyplure [(Z, Z) and (Z, E) 7, 11 hexadecadienyl acetate] were installed on four potential sites of PBW to catch the moths. Data regarding PBW moths catch in sex pheromone traps were recorded on weekly basis while metrological factors effecting PBW moths catch were recorded on daily basis. Relationship between the moths catch and weather factors were computed by simple correlation. The results concluded that maximum mean moths catch were recorded in those traps that were installed near cotton sticks heaps i. e 85.61 followed by cotton field 24.47. The lowest average number of moths catch was captured in traps of cotton seed store 1.22. The highest moths mean population 3.87 was trapped in the month of September from cotton field traps, however no moth was recorded during the month of December among all the sites. The moths catch in traps installed near cotton sticks heaps site has positive correlation with mean maximum and minimum temperature while has non-significant correlation with relative humidity and rainfall. Cotton sticks heaps are the major harboring sites of PBW infestation to the successive cotton crop.**

Keywords: *Pectinophora gossypiella*, Moths catch, Cotton sticks heap, Environmental factors

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1. INTRODUCTION:

Cotton is one of the most important commercial crop of Pakistan and a source of business, considered as king of fiber crops by sharing 65% in oil production (Saleem et al., 2018, Asif et al., 2013). It has a pivotal role from economic point of view in earning foreign exchange by exporting raw cotton to foreign countries. As Cotton is a long duration crop and is succulent in nature, so it is affected by both biotic and abiotic stresses causing greater loss to this crop (Hamayoon et al., 2013). Among biotic factors, arthropods causing 30-40% yield loss in cotton including complex of insect pests' worldwide (Abdullah, 2010, Haque, 1991, Kannan et al., 2004). The yield and area of cotton crop is continuously decreasing in Pakistan due to the attack of insect pests (especially the PBW and whitefly), poor seed quality, low market price and climate change (ESP, 2019-20). These pests are controlled by applying synthetic chemicals which account 25% of total consumed insecticides on cotton crop worldwide (I. C.A.C, 2000).

PBW (*Pectinophora gossypiella*) is the most devastating pests among all the bollworms in Pakistan and is difficult to control with insecticides (Lykouressis et al., 2005). This pest is gaining attention now a days by causing yield loss about 20-30%, which is about one million cotton bales. PBW deposit eggs on the sutures or under

the bracteoles at the base of the boll, specifically on 14 days old bolls, larvae hatched from eggs and entered into bolls or flowers within 20-30 minutes (Hutchison et al., 1988) or within 2 hours (Ingram, 1994). Quick entrance into boll and internal feeding as well as camouflaging in rosette flowers, higher reproductive potential and oviposit preference of female moth in sheltered places making its chemical control impossible with conventional insecticides.

Hummel et al., 1973 and Bierl et al., 1974 monitored the cotton chewing insect pests namely *Helicoverpa armigera, Earias* species, *Pectinophora gossypiella* and *Spodoptera litura* under field conditions by using different types of sex pheromones. The pheromone used for monitoring and mass trapping and mating disruption of PBW was isolated and identified. The moths catch through pheromone traps play an important role in population estimating of PBW and their correlation with environmental factors is the key in decision making process for its control.

There is dire need of time to develop an effective management strategy against PBW through uprooting the off-season sites which provide shelter to the larvae diapaus and subsequently infesting the next crop. Its monophagous nature and limited number of alternate Host plants like okra, *Abelmoschus esculentus* (L.), (Noble, 1969), is a major reason behind the failure of management approaches. Considering the above-mentioned particulars, the present study was designed to find the potential sites of PBW larvae sheltered in cotton bolls, cotton sticks heaps or seeds in seed stores and within the soil based on moths catch.

The study objectives were; (a) to identify main harboring sites of PBW moth emergence (b) identify the correlation between male moths catch in sex pheromone trap with the environmental factors.

2. MATERIAL & METHODS:

2.1 Study Area:

In this experiment Pink bollworm moths catch were recorded throughout the year 2018 from different PBW moth emergence sources. The treatments were as follow:

T_1 = Cotton sticks Heap
T_2 = Cotton ginning factory
T_3 = Cotton seed store
T_4 = Cotton field

The cotton sticks heaps traps (T1) were installed at Chak No.19/M.R (Latitude 30.15, Longitude 71.44, Altitude 225.81ft). Ginning factory (T2) traps were installed at Khawaja Muzaffar Mahmood Cotton Factory, old Shujaabad Road Multan (Latitude 30.09, Longitude 71.41, Altitude 514.10ft). The traps were also installed at Tariq Seeds (T3) Mujahid Town store Multan (Latitude 30.16, Longitude 71.43, Altitude 248.71ft). In cotton field (C-Block) of Muhammad Nawaz Shareef University of Agriculture Multan traps (T4) were placed (Latitude 30.14, Longitude 71.44, Altitude 232.26ft). All treatments were replicated thrice with RCBD design.

2.2 Data Recording:

Weekly data of moths catch were recorded to observe the emergence sites of pink bollworm whole year. After counting the catch, moths were destroyed.

2.3 Statistical Analysis:

After whole year data compilation, moths catch comparison was analyzed statistically to find the harbor sites of pink bollworm for its future off-season management. The mean moths catch from different sites were also subjected to ANOVA and were compared by LSD test. The meteorological data was also recorded to correlate the moth emergence with temperature and other abiotic factors.

3. RESULTS:

3.1 PBW Moths Catch from different harboring sites:

The use of pheromone traps is best tool for sampling of flying insects. The current study was designed to find the moths catch emergence from different possible sources of pink bollworm through installing pheromones traps. From table 1 it is clear that moth emergence in the month of January was zero from all sites. In the month of February the PBW moth emergence from the cotton sticks heaps source (T_1) was 3 (Average moth catch/trap/day 0.03). Amongst four different sites of PBW the moth emergence from cotton ginning factory (T_2) and cotton seed store (T_3) was zero. The moths catch were 2 (Average moth catch/trap/day 0.66) in cotton field source (T_4). With the increase in temperature the PBW moth emergence rises in the month of March. In cotton sticks heaps source (T_1) there were 155 (Average moth catch/trap/day 1.66) moths were catched. While in cotton factory (T_2) 5 moths were captured. In seed store (T_3), Cotton field (T_4) 7, 6 moths were caught during the whole month. The moths catch in the month of April from different sources i.e. T1, T2, T3, T4 were 704, 4, 16, 29 respectively. In the month of May moth trapped in pheromones traps were 816 and 3 in T1 and T2 respectively. In T3, T4, it was 13, 34 and 36 respectively. The pheromones traps installed near cotton sticks heaps source trapped 728 (Average moth catch/trap/day 8.08) moths during the month of June and in other sources T2, T3 and T4 the moth captured were 4 (0.044), 8 (0.088), 26 (0.28) respectively.

In the month of July the moths trapped in different sources were 360, 1, 0 and 38 in T1, T2, T3 and T4 respectively. In the month of August moths catch in different sources like T1, T2, T3, T4 were 162 (Average moth catch/trap/day 1.74), 5 (Average moth catch/trap/day 0.05), 0 (0), 234 (Average moth catch/trap/day 2.51) respectively. In the month of September 36, 48, 0, and 349 moths were catched in T1, T2, T3 and T4 respectively. In the month of October 17 (Average moth catch/trap/day 0.18) moths were caught in T1 and 99, 0 and 198 moths were catched in the sources T2, T3 and T4 respectively. During November moths catch were 3, 10 and 0 in T1, T2 and T3 source respectively. In T4 moths catch in pheromones traps were 12. During the whole year 2018 total moths as well as average moth per trap per month from different sources were as 2984 (2.72), 179 (0.16), 44 (0.04) and 930 (0.84) T1, T2, T3 and T4 respectively as shown in table 1.

Table 1. Population of Pink Bollworm moths from different Sites in different months during 2018

	Cotton Sticks HeapsT1			Cotton FactoryT2			Seed Store T3			Cotton Field T4		
Months	Total Moth Catches	Av.Moth Catches/ Trap/day	SE	Total Moth Catches	Av.Moth Catches/ Trap/day	SE	Total Moth Catches	Av.Moth Catches/ Trap/day	SE	Total Moth Catches	Av.Moth Catches/ Trap/day	SE
January	0	0.00	0	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00
Feburary	3	0.04	0.58	0	0.00	0.00	0	0.00	0.00	2	0.67	0.33
March	155	1.67	4.91	5	0.05	0.67	7	0.08	0.67	6	0.06	0.58
April	704	7.83	19.60	4	0.04	0.67	16	0.18	0.33	29	0.32	0.88
May	816	8.77	5.86	3	0.03	0.58	13	0.14	1.45	36	0.39	1.00
June	728	8.09	3.84	4	0.04	0.88	8	0.09	0.67	26	0.29	0.88
July	360	3.87	8.72	1	0.01	0.33	0	0.00	0.00	38	0.41	4.67
August	162	1.74	5.51	5	0.05	1.67	0	0.00	0.00	234	2.52	5.29
September	36	0.40	1.00	48	0.51	7.13	0	0.00	0.00	349	3.88	9.87
October	17	0.18	1.86	99	1.67	5.84	0	0.00	0.00	198	2.13	1.15
November	3	0.03	0.00	10	0.11	0.33	0	0.00	0.00	12	0.13	2.08
December	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00

3.2 Correlation of PBW Moths Catch with Environmental Factors:

As shown in table-3 cotton sticks heap source (T_1) has highly significant positive correlation of PBW moths catch observed with average maximum and minimum temperature, and mean temperature but negative significant correlation was observed with humidity and positive non-significant relation was observed with rainfall. In source (T_2) cotton factory, positive non-significant correlation was recorded of PBW moths catch with minimum average temperature and humidity, while with maximum average temperature and rainfall the correlation was negative non-significant.

Correlation between pink bollworm

Table 2. Av. Maximum, Av. Minimum, Mean Temperature, Humidity and Rainfall (mm) data recorded at Multan during the year 2018

Months	Av.Min. Tem.	Av.Max.Tem.	Mean Temperature	Humidity	Rainfall (mm)
January	7.6	19.7	13.65	83.1	0
February	12.2	22.8	17.50	75.4	6.8
March	16.7	30.3	23.5	70.9	0
April	22.8	36.1	29.45	56.7	0
May	27.1	38.6	32.85	52.6	0
June	30.3	38.9	34.60	64.7	2
July	29.8	36.6	33.20	71.2	9
August	28.9	35.9	32.40	75.1	2
September	34.9	24.8	29.85	77.1	0
October	16.8	29.3	23.05	75.1	0
November	09.6	28.2	18.90	82.3	0
December	07.3	21.2	14.25	85.0	0

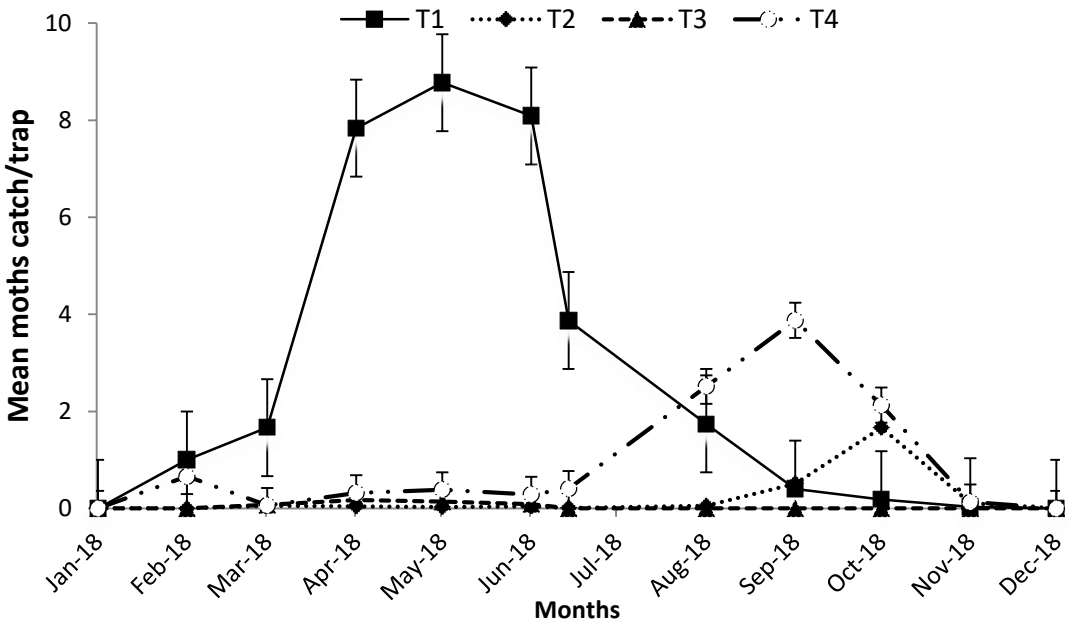

Figure 1. Month wise mean numbers of moths catch per trap from different sites

moths catch with different environmental factors in seed store source (T_3) was as describes here like positive non-significant correlation with average minimum temperature and mean temperature, positive but significant relation with average maximum temperature. Negative correlation was observed with humidity and rainfall but in case of humidity correlation was highly significant but non-significant with rainfall. When results are concluded in cotton field source (T4) that showed a positive non-significant correlation of moths catch with average minimum, mean temperature and relative humidity but correlation was non-significant negative with average maximum temperature and rainfall.

Table 3. Correlation of Pink Bollworm Moth Population with different environmental Factors

Moth Catch Source	Av.Temp. Min.	Av.Temp.Max.	Mean Temp.	RH	Rainfall
Cotton Sticks Heaps (T1)	0.5518*	0.8276**	0.7217*	-0.9247ns	0.0108ns
	P=0.0001	0.0009	0.0081	0.00	0.9733
Cotton Ginning Factory (T2)	0.1081ns	-0.1099ns	-0.0192ns	0.1334ns	-0.2701ns
	P=0.7381	0.7338	0.9528	0.6794	0.3959
Cotton Seed Store (T3)	0.2869ns	0.6104*	0.4562ns	-0.8969**	-0.2880ns
	P=0.3660	0.035	0.1361	0.0001	0.3641
Cotton Field (T4)	0.5696	0.0197ns	0.3701ns	0.1148ns	-0.1690ns
	P=0.0532	0.9514	0.2363	0.7224	0.5994

**** = Highly Significant at p <0.01 * = Significant p <0.05 ns = Non-significant**

Table 4. Average number of Pectinophora gossypiella moths trapped during different months from January to December 2018

Month	Average Moth Catch
January	0.0000 c
February	0.41 c
March	14.41bc
April	62.83ab
May	72. 33 a
June	63.83 ab
July	33.25 abc
August	41.50 abc
September	31.83 abc
October	30.83 abc
November	2.08c
December	0.0000 c

Table 5. Average number of Pectinophora gossypiella moths trapped from different Sites in 2018

Moths Catch Sites	Average Moths Catch
Cotton Sticks Heaps (T1)	85.611 a
Cotton Factory (T2)	6.472 b
Seed Store (T3)	1.222b
Cotton Field (T4)	24.472b

3.3 PBW Moths Trapped During different Months:

The table-4 showed that moth population captured in different months of the year was different. Results revealed that with the exception of two months January and December moths remained active throughout the year, so moths catch results in these months are similar and significantly different from other months. Moth population starting from the month of April to October was significantly high as compared to other months and minimum in the month of February. Three moth populations peak was observed during whole year. During April and June months moth population was non-significantly different from each other.

3.4 Average Moths Catch from Different Sites:

Increase in moth population observed from different sites revealed that maximum buildup of moth population was observed in cotton sticks heaps (T_1) 85.611 after this in cotton field (T_4) 24.47 and minimum in seed store (T_3) 1.22 as shown in table 5.

4. DISCUSSION:

The above results manifest that three moth populations peaks were recorded one in May 72.33, 2nd in June 63.83 and third in April 62.83. The seasonal population data pattern of PBW along with temperature record is shown in the Table 1 and 2. Qureshi *et al.* (1993) reported that moth population with the exception of a few days in the month of June remained active throughout the year. Minimum population was observed during months i.e. February & November. The emergence of moths in March and April months drastically increased and started rising in May and reached to peak in October in cotton field source. Two moth population peaks noted, one in May/June in T1 source and a second larger one in September/October in T4 source. These results are in confirmation with the results of Khan *et al.,* (2003), who reported higher level of pink bollworm infestation during October as 16.07% on flowers, 8.99% on squares and 11.43% on green bolls, while temperature ranges (28.31-30.08° C) humidity ranges from (46.91-53.50%) with no rainfall. The results are also in confirmation with Korejo *et al.*, (2000) who reported peak moth population in the month of September. Similar pattern was observed by the Rice and Reynolds (1971) and Kaae *et al,*. (1977).

The results are in contradiction with results of Ahmed (1979) who observed maximum moth population in February, March and first lower peak in March and second lower peak in April. Present research revealed that with the exception of two months January and December moth remained active throughout the year that are in confirmation with the results of Ali *et al.*, (2015) who described that traps capturing of *P. gossypiella* moths catch were very low (almost zero) during January and contradictory with the finding of Korejo *et*

al. (2000) who reported that with the exception of January, moths of PBW remained active throughout the year. Present results are identical and the difference might be due to the climatic conditions difference of that area.

The results differ from that of Ahmad (1980) who reported the maximum pink bollworm moth population in February to March and minimum population in April. He further recorded a low moth population during May-December. Such types of results are contradictory to the present findings that could be due to change in climatic conditions under which the experiment was conducted.

PBW population fluctuation can be carried out by different environmental factors. In the month of September when maximum population was observed the average maximum and minimum, mean temperature, humidity and rainfall was 34.9, 24.8, 29.85, 77.01 and 0 respectively. All other weather factors have a significant impact on PBW moth population buildup except rainfall. The results are not confirmed by the results of Ali *et al.* (2016) who noted positive relation between maximum temperature and rainfall, while minimum temperature, mean temperature and humidity had a negative impact on the PBW moth population.

Current results are also in conformity with Chaudhary *et al.,* (1999) and Guirguis *et aI.,* (1999) who noted maximum PBW moth population during September, when the temperature and relative humidity ranges 25.0-35.0 ^{o}C 45.0-55.0% respectively with no rainfall. Same results were revealed by Nasir (1986), who reported a significant negative correlation of PBW moths catch with abiotic factors and non-significant correlation with rainfall. The results of present research are different from Jha and Bisen (1994) findings who reported that rainfall is an important factor for infestation and development of this pest. There are many other factors like physio-morphological or bio-chemical that having influence on PBW population dynamics. These factors may correlate with each other and have some positive or negative effect on pink bollworm infestation.

From current study results only cotton sticks heap site has significant correlation with temperature factor of environment while other three sites have nonsignificant correlation with temperature. Present results are same with the results of Kaur *et al.* (2016) who reported PBW catches have no significant effect on maximum and minimum temperature as well as having negative relation with evaporation and rainfall.

5. CONCLUSION:

From the results of moths catch from different sites of PBW i:e. month-wise average moths catch in cotton sticks heaps 85.61, cotton ginning factory 6.47, cotton seed store 1.22, and in cotton field 24.472. It is very clear that maximum infestation site of PBW is cotton sticks heap, so disposing of these sticks is very necessary for management of PBW. It is also necessary that proper disposing of waste from cotton ginning factory as well as ploughing of field after cotton crop is necessary for PBW management.

6. AUTHOR CONTRIBUTION:

MN conducted the experiment and wrote the manuscript, SS planned the experiment, UNU, FN and QA critically reviewed the manuscript while QA helped in data collection

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8. CONFLICT OF INTEREST:

Authors have no conflict of interest.

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