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Impact of ginning mills and Weather parameters on population of Pink bollworm *Pectinophora gossypiella* (Saunders)

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ABSTRACT

In the recent times pink bollworm has emerged as a serious pest of cotton in India causing ecological and economic damage. For proper management of pink bollworm it is very important to know source of infestation along with survival during offseason. Monitoring of pink bollworms was done in 2018 and 2019 in Adilabad district of Telangana. For this market area of Adilabad having 10 ginning mills and 15 villages surrounding the mills with an radius of 5, 10 and 15 km were selected. In ginning mills average moth catches started in September measuring 0.20moths/trap/week and a peak was observed on 26th March and 1st April recording 158.2moths/ trap/week. There it declined to 120moths/trap/week during the end of April then became negligible by July. Average moth catches at the field started in August measuring 21.27moths/trap/week. The peak level of adult activity in the season was recorded in 3rd week of February recording 117.13 moths/trap/week. The later population became negligible by June. Temperature showed a significant negative correlation with trap catches of month/week. A decrease in the number of moth catches/trap/week was observed with an increase in radius from ginning mills. Average catches of male moths in traps set at 5, 10, and 15 km away from ginning mills revealed 42.63, 35.68, and 29.94 moths/trap/week respectively.

Keywords: *Pink bollworm, Monitoring, Ginning mills, weather parameters, trap catches.*

INTRODUCTION

Pink bollworm, *Pectinophora gossypiella* (Saunders) a pest of cotton having national importance was reported in India for the first time in 1843. Recently this pest became serious on BG II cotton hybrids, which became economically the most destructive insect pest of cotton. The main attributes for this issue include non-compliance of refuge, too many Bt hybrids of different durations, mono-cropping with extension of crop season, and lack of proper monitoring of bollworm and its resistance to gene and congenial climate [1]. In addition, reports on the development of resistance in laboratory strains or field-evolved resistance to Cry1Ac [2] and Cry2AB [3] or both genes.

During early incidence, the larvae of pink boll worm (PBW) are found in flowers feeding on anthers and pollen by living in a sort of web, which characteristically show twisted form of flowers that is called as rosette. Later stage of the crop the larvae bore into the green bolls, and further burrow into developing bolls through the lint penetrating deep into seeds. When one seed is consumed, the larvae tunnel and enter through the developing lint and migrate to another seed and similarly to other locules. The affected, larvae emerged bolls get rotten and shed while, those retained on the plants open prematurely resulting in stained immature fiber, causing an 80 percent reduction in seed cotton yield and quality of lint [4]. Pupation of PBW occurs in a flimsy cocoon in the boll, often in the seed hallowed out by larva or in soil.

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Pink bollworm has a tendency to enter into facultative diapause in some temperate and tropical regions of the world. Induction and termination of diapause majorly depends on seasonal changes such as temperature and photoperiod in addition to availability of food etc.

Generally, the activity of PBW was observed during the late crop season beyond December after the first picking of cotton and the cycle later advanced to October-November. During 2018, PBW incidence was seen in August itself [5] which was in the early flowering stage. During off season, aggravation of pest was observed specially near ginning mills, which is the major source for pink bollworm, gathered through cotton stocks procured from farmers. Due to the severity of the pest over the past three years, an attempt was made for the present study

MATERIAL AND METHODS

Monitoring of Pink bollworm

As a part of the observation of monitoring the occurrence of Pink bollworms throughout the year under field conditions, a survey was undertaken in Cotton cotton-growing area in the Adilabad district of Telangana. For this purpose, the market area of Adilabad district having 10 ginning mills (Table 1) and 15 villages in a radius of 5, 10, and 15 km surrounding the ginning mills (Table 2) were selected (fig 2).

Ginning mills

Inside the ginning mills, 10 Pheromone traps were installed in each, and data regarding moth catches was recorded weekly for one year starting from the first week of August 2018 to the last week of July 2019 and the lures were changed at 30-day intervals.

Fields located at different radius

Under field conditions, eight pheromone traps were installed in each field of one acre area, 1-2 meters above the plant height. Five villages from the mentioned radius were selected. Villages include Ponnari, Pochera, Anukunta, Pipperwada, and Kajjarla which are in a 5 km radius, Sunkidi, Seethagondi, Boraj, Mediguda, Yalaganda in a 10 km radius whereas Jainath, Nirala, Talamadugu, Gudihathnoor, and Tamsi in 15 km radius from ginning mills at Adilabad district. Data on pheromone catches was recorded weekly from the first week of August 2018 to the last week of July 2019 and lures were changed for every 30 days.

RESULTS AND DISCUSSION

Monitoring of Pink bollworms in ginning mills and fields located at different radius

In the ginning mills, no moths were trapped from August to the first week of September 2018. However, slow moth catches were observed from the second week of September corresponding to 37th SMW with less than 50 moths/trap/week up to November 2018 which slowly increased to 95.6 moths/trap/week by the first fortnight of January corresponding to the 2nd SMW. Then catches increased to a maximum of 158.2 moths/trap/week by the end of March 2019 corresponding to the 13th SMW (fig 3). This sudden increase in moth catches might be due to the fresh cotton stock brought from fields for ginning during January and February, from which the larvae might have completed pupation during February due to the favorable temperature (21.70°C to 28.14C) which ultimately resulted in adult emergence reaching to peak level by March. Later moth catches slowly declined to minimum of 20.4 to 1.0 moths/trap/week by May, 2019 and became zero during second fortnight of June-July.

Data presented in Table 3, about the distribution of pink bollworms from the source *i.e*. ginning mill in terms of adult moth catches through pheromone traps installed at different distances *i.e.* 5 km, 10 km, and 15 km away from ginning mills revealed that in general as the distance increased, the adult moth catches were decreased *i.e.,* at 5 Km distance, minimum of less than 5 moths/trap/week, at 10 km distance, minimum of less than 1 moths/trap/week were recorded during May to July and at 15 km distance, no moths were trapped during May to June. Otherwise, the maximum number of moths caught per trap per week, at a 5 Km distance, was more than 100 moths/trap per week from January to April, at a 10 km distance it was more than 80 moths/trap per week during January to April and at 15 km distance more than 70 moths/trap/week were recorded during the first fortnight of January to the third week of March, 19. Which gradually reduced by May 19(fig 4).

Under field conditions, average adult moth catches of Pink bollworm were observed starting from the first week of August corresponding to 32nd SMW recorded as 35.40, 20.80, and 7.60 moths/trap/week at 5, 10, and 15 km radius respectively, coinciding with the one-month aged crop. Thereafter, trap catches gradually increased and a sudden fall in the moth catches was observed during the third week of September (38th SMW) recording 5.5, 3.5, and 2.2 moths/trap/week at 5, 10, and 15 km radius respectively during the square formation stage of the crop. Later fluctuation in moth catches was recorded and the first peak was noticed in 3rd week of November (46th SMW) recording 35.8, 24.1, and 17.9 moths/trap/ week at 5, 10 and 15 km radius respectively when the crop was in open boll stage. These results were in close conformity with the findings of [6] who reported progressive build-up of pink bollworm population starting from November[7]. also observed gradual increase in adult trap catches from 3rdweek of November (46th SMW) to 2nd week of December (49th std. week), but at full bloom stage of the crop which might be due to delayed sowing.

A sudden spurt in moth emergence was witnessed at 48 SMW and continued to increase till 3rd week of January (3rd SMW) which was recorded as 102.2, 87.4, 70.0 moths/trap/week at 5, 10, and 15 km radius respectively and highest trap catches for the season was recorded during 2nd week of February (7th SMW) as 122.6, 116.2 and 112.6 moths/trap/week at 5, 10 and 15 km radius respectively when the crop is in mature boll stage. Later, a decrease in trap catches was observed recording 19.79, 15.08, and 13.20 moths/trap/week at 14 SMW, and became negligible during June and July. These findings are in agreement with the reports of [8] who observed peak pheromone trap catches during 50th and 5th standard weeks. Similarly [9] from Pakistan also reported increased infestation of pink bollworms from February to March. Present results gave an idea for predicting the time of infestation by PBW about two weeks before adult moth catches in the trap. Based on the observations made in the present study about more moths trapped during November continuing up to February show infestation of Cotton bolls might have occurred during September, ultimately resulting in peak catches from November continuing up to February which was supported by the favorable weather conditions (temperature ranging from 18.96°C to 28.14°C)(fig 5).

In contrast to the present results [10] reported that under Punjab conditions, moth emergence started during the first fortnight of March with peak moth emergence during the first week of October. [11] also reported that the peak population of pink bollworm could be observed in April, May, June, October and November [12] recorded seasonal incidence of pink bollworm and recorded high population of pink bollworm during October – November and April. This variation in the observation of peak population of adult PBW moths might be due to the difference in time of planting or maintenance of ratoon cotton crop as well as weather parameters exclusively, temperature, relative humidity and rainfall.

On an average, less than 25 moths/trap/week were trapped from the second week of August 2018 to the first week of November2018. However, the population increased gradually from 32.6 to 117.13 moths/trap/week reaching the peak. The level of incidence in terms of moth catches started decreasing from 95.73 moths /trap/week to 50.21 moths /trap/week during March from April onwards, further moth catches gradually decreased from 16.02 to 2.45 moths /trap/week by July,19. Trap catches showed a significant negative correlation with max temperature (r= -0.401), min temperature (r= -0.503), and average temperature (r= -o.475). No significant relationship was found with relative humidity, BSSH, and rainfall (table 4).

CONCLUSION

From the present study, it can be concluded that the Peak population of pink bollworms was recorded during February and march months in field and ginning mills because of delayed crop termination, availability of seed cotton for ginning in mills, and favorable climatic conditions for pest multiplication. Year-round trap catches of pink bollworm were recorded and Ginning mills are acting as the main source of survival during the offseason helping in the dissemination of pests to surrounding fields when the crop is sown. Management practices in ginning mills like mass trapping, and destruction of leftover cotton very essential. In the main field regular monitoring integrated management strategies, and timely termination of crops are necessary as the pest appears in the early stage of the crop.

ACKNOWLEDGEMENT
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CONFLICT OF INTEREST
The authors declare there is no conflict of interest

FUTURE SCOPE
Further there is a need to frame proper management practices to avoid survival of pink bollworms during offseason.

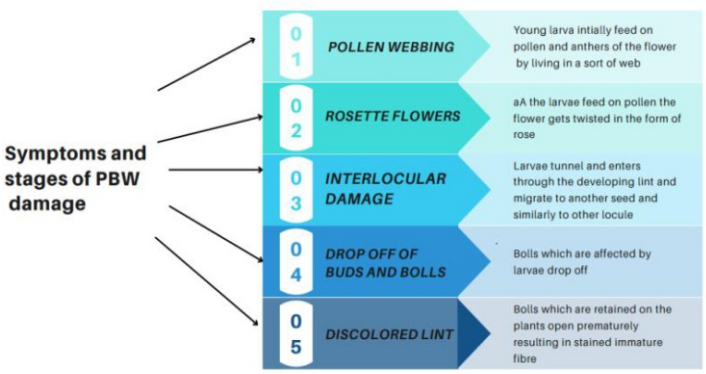

Fig: 1 symptoms and stages of damage by pink bollworm

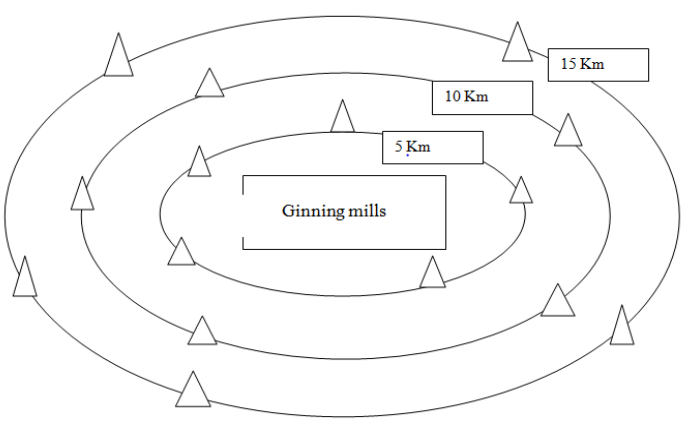

Fig: 2 Diagrammatic representation of radius of distribution of cotton fields from Ginning mills

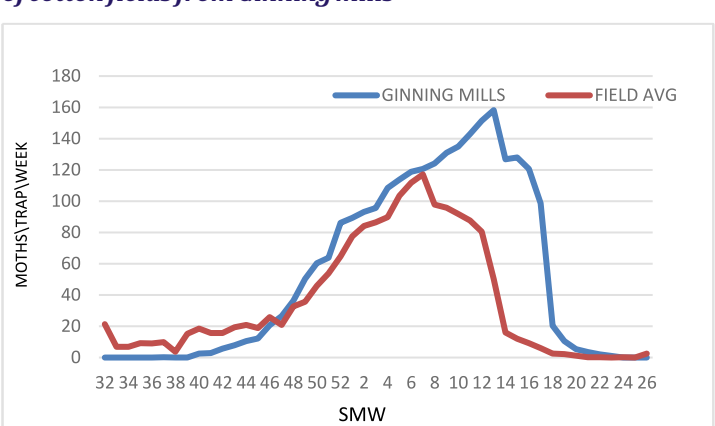

Fig.3 Average trap catches of Pink bollworm in field and ginning mills

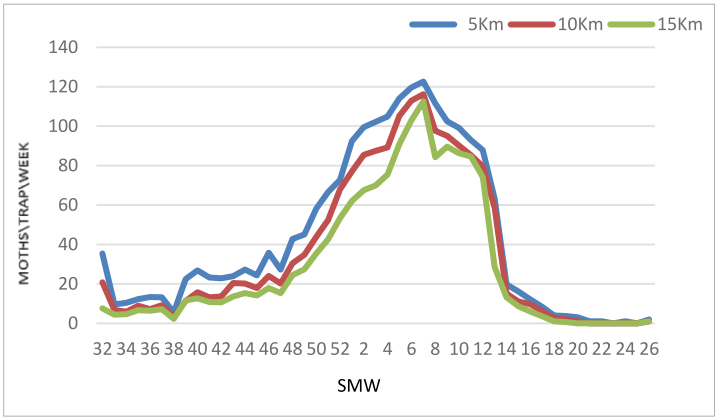

Fig.4 Trap catches of Pink bollworm in fields surrounding ginning mills within radius of 5, 10, 15 km

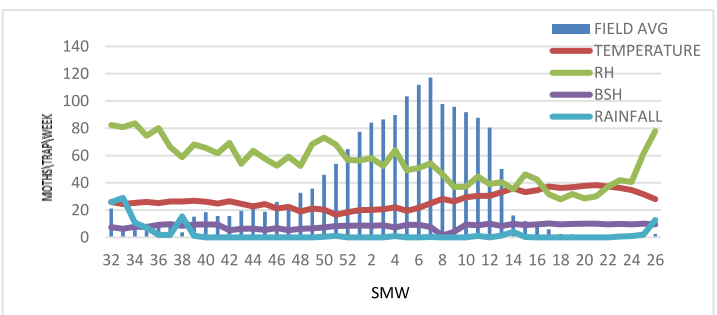

Fig.5 Effect of weather parameters on trap catches of Pink bollworm

Table 1. Location of ginning mills at Adilabad district

S.no	Ginning mills	GPS location
1.	Ganesh ginning	19.679N78.525E
2.	Chanakya ginning	19.682N78.520E
3.	G.V.K cotton ginning	19.681N78.518E
4.	YuvarajAgritech	19.684N78.511E
5.	Sowmya cotton mill	19.681N78.497E
6.	Hemanth industry	19.685N78.499E
7.	Paramatma cotton Pvt industry	19.688N78.498E
8.	Saibaba ginning mill	19.679N78.523E
9.	Sri mahalakshmi cotton mill	19.685N78.511E
10.	Malaparni cotton mills	19.683N78.506E

Table 2. Location of villages surrounding ginning mills

S.no	Radius	Villages	GPS location
1.	5Km	Ponnari	19.679N78.480E
2.		Pochera	19.334N78.360E
3.		Anukunta	19.699N78.585E
4.		Pipperwada	19.767N78.565E
5.		Kajjarla	19.630N78.458E
6.	10Km	Sunkidi	19.662N78.412E
7.		Seethagondi	19.573N78.495E
8.		Boraj	19.740N78.545E
9.		Mediguda	19.659N78.575E
10.		Yalaganda	19.660N78.590E
11.	15Km	Jainath	19.731N78.633E
12.		Nirala	19.733N78.603E
13.		Talamadugu	19.645N78.395E
14.		Gudihatnoor	19.544N78.501E
15.		Tantoli	19.533N78.558E

Table 3. Spatial distribution and trap catches of Pink bollworm and weather parameters

Date	SMW	Average PBW moths /trap/week												
		Ginning mills	Field				Temperature⁰ C			Relative humidity%			BSH(hrs.)	Rainfall (mm)
			5Km	10Km	15Km	Avg	Max	Min	Avg	I	II	Avg		
06 Aug- 12 Aug	32	0.00	35.4	20.8	7.6	21.27	31.7	20.3	26.0	81.90	82.9	82.4	7.4	25.8
13 Aug- 19 Aug	33	0.00	9.6	6.8	4.4	6.93	28.97	19.83	24.40	86.86	74.71	80.79	6.29	29
20 Aug- 26 Aug	34	0.00	10.4	5.8	4.6	6.93	30.73	19.81	25.27	84.00	83.29	83.64	7.81	10.8
27 Aug - 02 Sep	35	0.00	12.23	8.92	6.65	9.27	31.77	20.20	25.99	80.14	68.71	74.43	7.57	7.17
03 Sep - 09 Sep	36	0.00	13.4	7.2	6.4	9.00	31.00	19.19	25.09	82.71	77.57	80.14	9.11	1.8
10 Sep - 16 Sep	37	0.20	13.2	9.2	7.2	9.87	34.30	18.43	26.36	71.86	60.57	66.21	9.77	1.83
17 Sep - 23 Sep	38	0.10	5.5	3.5	2.2	3.73	33.63	19.00	26.31	82.29	67.43	58.68	8.43	15.3
24 Sp - 30 Sep	39	0.10	22.4	11.4	11.6	15.13	34.34	19.36	26.85	74.86	61.29	68.07	9.4	1.14
01 Oct - 07 Oct	40	2.56	26.9	15.8	12.7	18.47	34.49	17.93	26.21	73.57	57.57	65.57	9.6	0
08 Oct - 14 Oct	41	2.86	23.2	13.2	10.8	15.73	34.50	15.11	24.81	66.43	57.00	61.71	9.39	0
15 Oct - 21 Oct	42	5.62	22.9	13.6	10.7	15.73	34.14	18.76	26.45	78.57	60.29	69.43	5.3	0
23 Oct - 28 Oct	43	7.94	23.9	20.5	13.6	19.4	34.94	14.14	24.54	65.71	42.14	53.93	6.29	0
29 Oct - 4 Nov	44	10.5	27.3	20.2	15.3	20.93	32.91	12.63	22.77	71.00	56.00	63.50	6.5	0
05 Nov-11 Nov	45	12.2	24.35	17.9	14.2	18.83	34.39	14.57	24.48	68.43	47.00	57.71	5.45	0
12 Nov-18 Nov	46	20.7	35.8	24.1	17.9	25.93	33.34	9.03	21.19	60.57	44.43	52.50	6.76	0
19 Nov- 25 Nov	47	26.5	27.3	20.2	15.3	20.93	32.61	12.24	22.43	67.86	50.57	59.21	5.32	0
26 Nov- 02 Dec	48	36.4	42.8	30.5	24.5	32.6	30.20	7.71	18.96	64.86	39.86	52.36	6.28	0
03 Dec – 09 Dec	49	50.4	45	34.8	27.4	35.73	30.60	11.84	21.22	80.86	55.86	68.36	6.68	0
10 Dec – 16 Dec	50	60.4	58.1	43.9	35.4	45.8	28.20	12.39	20.29	80.14	66.14	73.14	7.24	0.49
17 Dec – 23 Dec	51	63.8	66.6	52.4	42.6	53.87	25.27	7.94	16.61	77.00	58.86	67.93	8.39	1.11
24 Dec – 31 Dec	52	86.2	72.8	67.9	53.3	64.67	28.01	8.88	18.44	68.75	45.00	56.88	8.56	0
01 Jan – 07 Jan	1	89.3	92.4	77	62	77.47	30.30	9.70	20.00	67.30	45.40	56.35	8.7	0
08 Jan – 14 Jan	2	93.2	99.5	85.4	67.5	84.13	29.20	11.18	20.19	71.14	45.28	58.21	8.55	0
15 Jan – 21 Jan	3	95.6	102.2	87.4	70	86.53	30.90	10.30	20.60	66.40	38.40	52.40	8.9	0
22 Jan – 28 Jan	4	108.5	104.8	89.2	75.4	89.8	27.60	16.70	22.10	75.00	52.60	63.80	7.3	1
29 Jan – 04 Feb	5	113.8	114.1	105.2	90.9	103.4	29.33	9.67	19.50	61.43	37.14	49.29	9.2	0
05 Feb- 11 Feb	6	118.8	119.6	112.9	102.9	111.8	30.53	12.87	21.70	59.14	42.57	50.86	9.19	0
12 Feb- 18 Feb	7	120.6	122.6	116.2	112.6	117.13	33.57	16.34	24.96	66.43	42.14	54.29	7.67	0.26
19 Feb- 25 Feb	8	124.2	111.6	97.6	84.2	97.8	36.07	20.20	28.14	61.29	31.57	46.43	1.33	0
26 Feb – 04 Mar	9	131	102.5	95.05	89.6	95.73	35.10	17.40	26.25	50.29	23.57	36.93	4.03	0
05 Mar – 11 Mar	10	135	99.1	90.2	86.3	91.87	37.79	21.07	29.43	46.71	27.43	37.07	9.3	0
12 Mar – 18 Mar	11	142.9	93.0	85.32	84.69	87.65	37.50	23.33	30.41	55.86	33.57	44.71	8.91	1.2
19 Mar – 25 Mar	12	151.4	87.8	79.6	74.23	80.54	39.63	21.14	30.39	51.29	26.86	39.07	10.1	0
26 Mar – 1 Apr	13	158.2	63.28	58.75	28.6	50.21	41.61	24.74	33.18	47.29	33.71	40.50	8.3	1.24

Date	SMW	Average PBW moths /trap/week												
		Ginning mills	Field				Temperature⁰ C			Relative humidity%			BSSH hrs.	Rainfall mm
			5Km	10Km	15Km	Avg	Max	Min	Avg	I	II	Avg		
02 Apr -08 Apr	14	126.7	19.79	15.08	13.2	16.02	42.64	29.09	35.86	47.71	22.71	35.21	9.8	3.97
09 Apr - 15 Apr	15	128	16.2	11.1	8.69	12	40.67	25.69	33.18	57.29	35.00	46.14	9.1	0.31
16 Apr - 22 Apr	16	120.6	12.09	9.69	6.02	9.27	42.04	26.97	34.51	51.43	33.57	42.50	9.6	0
23 Apr- 29 Apr	17	98.7	8.39	6.14	3.54	6.02	44.50	30.14	37.32	40.29	23.00	31.64	10.2	0
30 Apr - 06 May	18	20.4	4.02	2.69	0.98	2.56	43.47	29.23	36.35	34.29	21.43	27.86	9.5	0
07 May - 13 May	19	10.6	3.67	2.1	0.7	2.16	43.50	29.96	36.73	37.57	26.14	31.86	9.9	0
14 May - 20 May	20	5.4	3	1	0	1.25	44.86	30.84	37.85	34.29	22.86	28.57	10.1	0
21 May- 27 May	21	3.5	1	0	0	0.2	45.26	31.39	38.32	38.71	21.57	30.14	10.1	0
28 May - 03 June	22	2	1	0	0	0.23	44.61	29.91	37.26	46.00	28.43	37.21	9.6	0
04 June - 10 June	23	1	0	0	0	0	42.86	29.79	36.32	50.71	33.00	41.86	9.9	0.64
11 June - 17 June	24	0.00	1	0	0	0.12	40.19	29.14	34.66	49.29	31.71	40.50	9.5	0.91
18 June - 24 June	25	0.00	0	0	0	0	37.39	26.00	31.69	66.71	56.29	61.50	10.1	2
25 June - 01 July	26	0.00	2	1	1	2.45	31.91	24.17	28.04	75.29	80.57	77.93	9.5	12.71
Mean			42.63	35.68	29.94									

SMW= Standard metrological week, RH I = Morning relative humidity, RH II = Evening relative humidity, BSSH = Bright sun shine hours

Table 4. Correlation between pink bollworm and weather parameters

	weather parameters							
particulars	Max temp C	Min temp C	Avg temp C	MorningRH %	Evening RH %	Avg RH %	BSSH	Rainfall
Pink bollworm trap catches/ week	-0.401**	-0.503**	-0.475**	0.021^{NS}	-0.226^{NS}	-0.101^{NS}	-0.262^{NS}	-0.261^{NS}

*** significant, ^{NS} non significant*

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