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Effect of weather factors on seasonal incidence of major sucking insect pests on *Bt* and non-*Bt* cotton under rainfed conditions of Odisha

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Abstract
A field experiment was carried out to study the effect of weather factors on seasonal incidence of major sucking insect pests on *Bt* and non-*Bt* hybrid (Bunny) cotton during *Kharif*, 2013 and 2014 at Regional Research and Technology Transfer Station farm at Bhawanipatna, Kalahandi, Odisha. The incidence of sucking pests was observed from 1st week of August (32nd SMW) and continued up to last week of December (52nd SMW). The population of aphids (42.16 and 59.32/ 3 leaves) at 37th and 36th SMW; jassids (15.62 and 16.40/ 3 leaves) at 40th and 41st SMW; thrips (2.32 and 2.82/ 3 leaves) at 41st SMW and 35th SMW; whiteflies (5.72 and 5.40/ 3 leaves) at 41st and 41st SMW; and red cotton bug (7.78 and 7.96/ plant) at 48th and 48th SMW attended the peak in the year 2013 and 2014 respectively. No significant difference was observed with respect to the population of any of the sucking pests on *Bt* and non-*Bt* cotton. The population buildup of aphids, jassids and thrips were positively correlated with the mean minimum, mean maximum and mean average temperature, morning, evening and mean relative humidity and rainfall while whiteflies positively correlated with mean minimum, mean maximum and mean average temperature and rainfall. Red cotton bug showed negatively non-significant correlation with all the weather parameters.

Keywords: Seasonal incidence, sucking insect pests, weather parameters, *Bt* and non-*Bt* cotton

Introduction
Cotton (*Gossypium hirsutum* L) enjoys a predominant position amongst all the cash crops in India which is also known as "white gold" and grown under diverse agro-climatic conditions [1]. India was a leading country in terms of area (123 lakh hectares) and production (28,500 million bales) of cotton during 2017-18, but the productivity was decreased from 541 Kg/ha during 2016-17 to 524 Kg/ha during 2017-18 [2]. The cotton crop is damaged by large numbers of insect pests than any other crops grown commercially which is a major contributing factor for low yield [3]. About 162 species of insect pests viz., defoliators, sap-suckers and tissue borers invade cotton. Among them the cotton bollworms are major serious insect pests [4]. India approved the commercial cultivation of *Bt* cotton in 2002 and since then, there was rapid adoption of the technology [5]. *Bt* cotton with Cry 1Ac + Cry 2Ab gene effectively managed *Helicoverpa armigera* (Hubner), *Earias vittella* (Fabricius) and *Pectinophora gossypiella* (Saunders). But there was no remarkable difference between the relative susceptibility to major sucking pests in *Bt* and non-*Bt* cotton. The sucking pests viz., green leaf hopper, *Amrasca biguttula biguttula* (Ishida), aphids, *Aphis gossypii* (Glover), whiteflies, *Bemisia tabaci* (Gennadius) and the thrips, *Thrips tabaci* (Lind.) caused considerable damage to the *Bt* cotton [6].

The infestation of bollworms has been curtailed to a large extent but at the same time the frequency of insecticide sprayings increased to curb the sucking pest menace. With the changing scenario of insect pest status under the impact of climate change in different agro-climatic conditions there is need to generate information on population dynamics of major sucking pests and pest damage potential in relation to the weather parameters on *Bt* and non-*Bt* cotton crop for predictive management of sucking insect pests. The study was conducted to analyze the effect of weather factors on seasonal incidence of major sucking insect pests viz., aphids, jassids, thrips, whiteflies and red cotton bugs on Bt and non-Bt cotton.

Materials and Methods
The present experiment was carried out by sowing *Bt* and non-*Bt* hybrid (Bunny) in two fixed plots during *Kharif* 2013 and 2014 at the Regional Research and Technology Transfer Station

(RRTTS), Bhawanipatna situated in the Kalahandi district in the Western Undulating Zone of Odisha. The crop was sown in the last week of June in both the years and the crop was managed throughout the experimental period following agronomical package of practices recommended for rainfed conditions [7] without any plant protection measure. The population of sucking pests viz., aphids, *A. gossypii;* thrips, *T. tabaci;* jassids, *A. biguttula biguttula* and whiteflies, *B. tabaci* were recorded at weekly interval on three randomly selected leaves from top, middle and bottom from 25 randomly selected plants during morning hours between 6:30 a.m. to 8:00 a.m. Similarly, for late season sucking pest i.e., red cotton bug, *D. cingulatus* the number of nymphs and adults were counted on the whole plant from 25 randomly selected plants at weekly interval. The population recorded for different sucking pests were averaged and subjected to T- test for testing any difference in occurrence of these sucking insects on *Bt* and non-*Bt* cotton and also the population data of different insect pests were subjected to statistical analysis to find out the simple correlation co-efficient with weather factors viz., temperature (Mean minimum, Mean Maximum and Mean average), relative humidity (morning and evening) and rainfall by using the standard formula as per Gomez and Gomez (1984) calculated in MS-excel,

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{S_1^2 - S_2^2}{n}}} \text{ Where, } \bar{X}_1 = \frac{\sum x_1}{n_1}, \bar{X}_2 = \frac{\sum x_2}{n_2}, S_1^2 = \frac{\sum x_1^2 - \frac{(\sum x_1)^2}{n_1}}{n_1}, S_2^2 = \frac{\sum x_2^2 - \frac{(\sum x_2)^2}{n_2}}{n_2}$$

$$r = \frac{\sum xy}{\sqrt{(\sum x^2)(\sum y^2)}}$$

Where, r = Simple correlation coefficient;
$x = X - \bar{x}, y = Y - \bar{y}$;

X = Variable i.e. mean number of insect pests;
Y = Variable i.e. abiotic component (Average temperature, relative humidity and rainfall)
The correlation coefficient (r) values were subjected to the test of significance using t-test:

$$t = \frac{r}{\sqrt{1-x^2}} X\sqrt{n-2}$$

Results and Discussion

Seasonal incidence of sucking insect pests in *Bt* and non-*Bt* cotton

Aphids, *Aphis gossypii* Glover

The incidence of aphids, *Aphis gossypii* started from 1st week of August (32nd SMW) in both *Bt* and non-*Bt* cotton and continued till 52nd SMW (24th to 31st December) during 2013 and 2014 (Table 1 and Fig. 1). The findings of earlier workers [8] also stated that the aphids in MECH 162 *Bt*, MECH 162 non-*Bt* noticed throughout the cropping season which supported the present investigation. The mean aphid population in 2013 and 2014 attained its plateau during 37th SMW (42.16/ 3 leaves) and 36th SMW (59.32/ 3 leaves) in *Bt* and non-*Bt* cotton respectively. The results Raja *et al.* [9] and Tomar [10] also revealed the peak incidence of aphids noticed at 37th standard week which continued to remain active up to 1st standard week which is close conformity with the present findings. However, no significant difference between mean population of *Bt* (11.18/3 leaves) and non-*Bt* (8.97/3 leaves) was observed during both the years. The above findings supported the view of previous researchers [11] who stated that there was no effect of *Bt* toxin expression on any of the sucking pests. No significant difference in the mean aphid population on *Bt* and non-*Bt* cotton has also been reported [12, 13].

Jassids, *Amrasca biguttulla biguttulla* (Ishida)

The jassid incidence was observed at 32nd SMW (1st week of August) and continued all over the crop season (Table 1 and Fig 1). Earlier it was revealed that the incidence of leafhopper in MECH 162 *Bt*, MECH 162 non-*Bt* and Brahma cotton cultivars recorded throughout the cropping season [8]. Which is corroborating the present investigation. Initially the jassid population was very low (0.28 and 0.26/ 3 leaves) in *Bt* and non-*Bt* cotton respectively. The jassid population increased slowly up to 37th SMW. Thereafter the mean jassid population increased rapidly and reached the peak (15.62/ three leaves) in *Bt* cotton at 40th SMW (1st week of October) while in non-*Bt* cotton (16.40/ three leaves) in 41st SMW (2nd week of October). The jassid population remained above the threshold level from 38th SMW (3rd week of September) to 44th SMW (1st week of November) in both the years. The insect population then started decline but continued till final harvesting. The present findings are in close conformity with the recorded incidence of leaf hoppers from 30th to 50th SMW with the peak activity at 41st SMW [14]. In general, no significant difference was observed in the mean seasonal jassids population of 6.84 and 6.32 per three leaves on *Bt* and 5.25 and 5.74 per three leaves on non-*Bt* cotton in the years 2013 and 2014 respectively. The work of the present author was in agreement with earlier results which indicated that there were no differences between the transgenic and non-transgenic hybrids in their relative susceptibility to cotton jassid, *Amrasca biguttula biguttula* [6, 15].

***Thrips tabaci* Linnman**

The thrips infestation was noticed from 32nd SMW and 33rd SMW in the year 2013 and 2014 respectively (Table 2 Fig. 2). The mean peak incidence of thrips in *Bt* cotton (2.32/ 3 leaves) during 41st SMW (8thto 14th October) and in non-*Bt* cotton (2.82/ 3 leaves) during 35th SMW (27th August to 2nd September) was observed in 2013 and 2014 respectively. The findings of the author are close conformity with the documented report on thrips population which remained active during the months of July and August [16]. Similarly, recorded peak incidence of thrips from 35th to 39th SMW (September) which is in accordance with present findings [17]. No significant difference was observed between the mean thrips population in both the year which varied from 0.04 to 2.32 in *Bt* cotton and 0.08 to 2.82 in non-*Bt* cotton. Earlier reported findings on non- significant difference in population densities of thrips in *Bt* and non-*Bt* cotton is in support of present findings [18]. Similar report on impact of transgenic cotton against population build-up of sucking insect pests of cotton substantiated the present findings [19].

Whiteflies, *Bemisia tabaci* Gennadius

The whitefly infestation was noticed from 32nd SMW (6th to 12th August) and continued till 52nd SMW (24th to 31st December) in *Bt* and non-*Bt* cotton during 2013 and 2014 (Table 2 and Fig 2) which is in conformity with the earlier investigation on the whitefly incidence on *Bt* and non-*Bt* recorded throughout the cropping season [8]. The peak activity was observed from 39th SMW (4th week of September) to 44th

SMW (4th week of October to 1st week of November) with a highest mean population of 5.72 and 5.40/ 3 leaves in *Bt* and non-*Bt* cotton respectively. The differences in peak incidence in different period was in line with the findings of earlier workers [20]. The reported incidence of low whitefly population throughout the season is in accordance with the present findings [21]. The present investigation revealed the whitefly population exhibited non-significant difference in *Bt* and non-*Bt* cotton which validated the findings of previous workers [18].

Red cotton bug, *Dysdercus cingulatus* Fabricius

The population of red cotton bug commenced from mid-October i.e. at 42nd SMW and continued up to 52nd SMW (24th- 31st December) (Table 3 and Fig 2). The population reached at its peak (7.78 and 7.96 bugs/plant on *Bt* and non-*Bt* cotton respectively) at 48th SMW (26th November- 2nd December) in both the years 2013 and 2014 i.e. during the peak boll bursting stage. The reported findings of highest population density of red cotton bug (1.58 per plant) on conventional cotton on 9th October is not in line with the results obtained in present investigation [22]. However, no significant difference observed in the overall mean seasonal red cotton bug population in *Bt* (5.20 bugs/plant) and non-*Bt* (5.43 bugs/ plant) recorded in the year 2013 and 2014 respectively. Earlier report on non-significant difference between the transgenic and non-transgenic *Bt* cotton in their relative susceptibility to red cotton bug is in harmony with present findings [6].

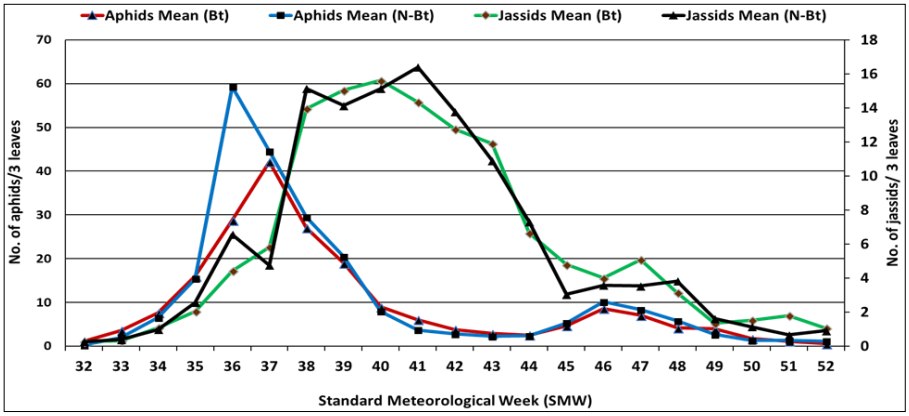

Fig 1: Seasonal incidence of aphids and jassids on Bt and non-Bt cotton during 2013 and 2014.

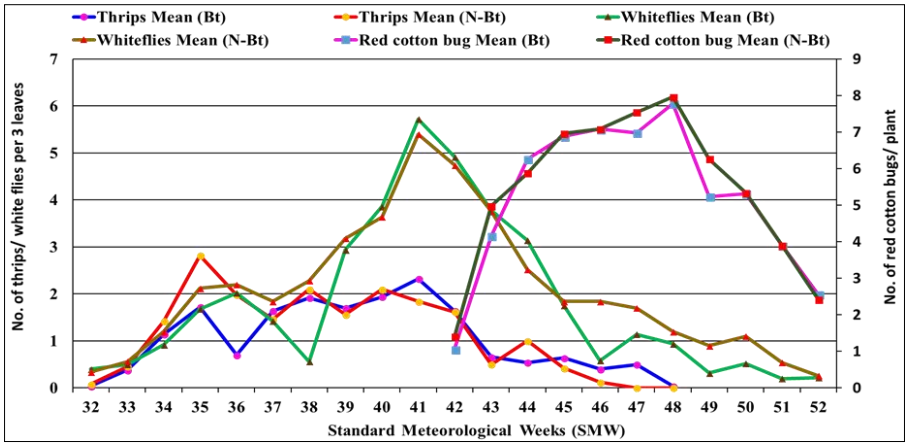

Fig 2: Seasonal incidence of thrips, whiteflies and red cotton bugs on Bt and non-Bt cotton during 2013 and 2014.

Effect of weather factors on incidence of sucking insect pests on *Bt* and non *Bt* cotton

During the study periods the average minimum, maximum and mean temperature recorded was 19.04, 29.90 and 24.47 ^{0}C in 2013 and 17.25, 30.74 and 24.00 ^{0}C in 2014 respectively. Similarly, the mean morning and evening RH was 84.79 and 76.94% in 2013 and 79.98 and 70.73% in 2014. The total rainfall received during the crop periods were 630.20 and 454.80 mm in 2013 and 2014 respectively.

Aphids

The correlation co-efficient of *A. gossypii* with weather parameters was positively correlated with maximum, minimum temperature, morning and evening relative humidity and rainfall in *Bt* and non-*Bt* cotton during 2013 and 2014 (Table 4). Earlier reported findings on coefficient correlation between aphid populations were positive with temperature, maximum relative humidity which was in close conformity with the present findings [23, 9]. During 2014 it was observed that population of aphids in *Bt* and non-*Bt* was significantly and positively correlated with RH and rainfall may be due to even distribution of rainfall which coincided with maximum activity period of aphids. The findings on the adverse effect of rainfall [14] and minimum temperature [20] on aphid population buildup differed from the results of present author.

Jassids

The result of present study showed non-significant but positive correlation between temperature and jassid population (Table 4). In 2013 it exhibited significant positive correlation with morning RH (r = 0.533, 0.544), evening RH

(r = 0.567 and 0.575) and mean RH (r = 0.560 and 0.570) in *Bt* and non-*Bt* cotton which favoured the population buildup. The jassid population showed non-significant but positive correlation with rainfall during both the seasons. Earlier to this the reported findings revealed jassid population was significantly and positively correlated with evening relative humidity and rainfall which corroborated the present findings [24].

Thrips

The population of *T. tabaci* was positively and significantly correlated with maximum temperature (r = 0.544 and 0.586 in *Bt* and non-*Bt* cotton respectively), minimum temperature with non-*Bt* (r = 0.482) and mean temperature (r = 0.549 and 0.597 in *Bt* and non-*Bt* respectively) during 2013 (Table 4). During 2014 the population of *T. tabaci* in non-*Bt* was significantly positively correlated with maximum (r = 0.610) and mean temperature (r = 0.508). The correlation studies of present investigation were similar with previous researchers [25].

Whiteflies

The correlation coefficient studies showed that *B. tabaci* population increased with increase of temperature and rainfall in *Bt* and non-*Bt* cotton during both the growing seasons. During the year 2013 the correlation of *B. tabaci* population with morning, evening and mean relative humidity was significantly positive in *Bt* (r = 0.530, 0.499 and 0.522 respectively) and non-*Bt* (r = 0.554, 0.569 and 0.571 respectively) cotton (Table 4). Whereas, it was positive but non-significant during 2014. The reported findings of earlier workers stated the significantly positive correlation existed between *B. tabaci* population and minimum temperature which was in accordance with the results of present studies [24].

Red cotton bug

The data (Table 4) showed that red cotton bug population was negatively and non-significantly correlated with temperature and rainfall during 2013 in *Bt* and non-*Bt* cotton whereas in 2014 the correlation coefficient of red cotton bug population with temperature, RH and rainfall was negative and non-significant in both the crops. The weather factors didn't show any pronounced effect on population dynamics of the red cotton bug during the present investigation.

Conclusion

The present investigation revealed that the sucking insect pests of early vegetative stage viz., aphids, jassids, thrips and whiteflies continued to infested both *Bt* and non-*Bt* cotton crop throughout the cropping season while the red cotton bug occurred between mid-October till harvesting without any significant difference in their abundance. Maximum activity of aphids, jassids and whitefly was noticed from 35th to 39th, 38th to 44th and 39th to 44th SMW respectively. The aphids, jassids, thrips and whitefly population was positively correlated with temperature, relative humidity and rainfall in both the years while Jassids population exhibited positive and significant correlation with morning, evening and mean relative humidity in 2013 while Aphids showed the same with relative humidity and rainfall in the year 2014. The red cotton bug did not show any significant correlation with any of the weather parameters.

Acknowledgement

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Table 1: Seasonal incidence of aphids, *Aphis gossypii* and jassids, *Amrasca biguttula biguttula* on *Bt* and non-*Bt* cotton under unprotected condition during 2013 and 2014.

SMW	Periods	Population of aphids (Nos) /3 leaves						Population of jassids (Nos) /3 leaves					
		2013		2014		2013 & 2014		2013		2014		2013 & 2014	
		Bt	N-*Bt*	*Bt*	N-*Bt*	Mean (*Bt*)	Mean (N-*Bt*)	*Bt*	N-*Bt*	*Bt*	N-*Bt*	Mean (*Bt*)	Mean (N-*Bt*)
32	6th – 12th Aug	1.12	0.36	1.16	0.08	1.14	0.22	0.28	0.16	0.28	0.36	0.28	0.26
33	13th – 19th Aug	3.20	1.68	3.92	2.24	3.56	1.96	0.24	0.24	0.40	0.52	0.32	0.38
34	20th – 26th Aug	6.16	7.52	9.04	5.48	7.60	6.50	1.64	0.60	0.52	1.36	1.08	0.98
35	27th – 02nd Sep	13.20	16.68	18.76	14.08	15.98	15.38	2.92	1.92	1.16	3.20	2.04	2.56
36	3rd – 09th Sep	22.04	62.52	35.52	56.12	28.78	59.32	5.64	5.36	3.20	7.76	4.42	6.56
37	10th – 16th Sep	40.96	45.12	43.36	43.96	42.16	44.54	6.08	3.84	5.56	5.68	5.82	4.76
38	17th – 23rd Sep	32.16	33.24	21.84	25.68	27.00	29.46	15.32	17.24	12.60	13.04	13.96	15.14
39	24th – 30th Sep	18.68	20.28	19.28	20.60	18.98	20.44	16.96	15.88	13.12	12.40	15.04	14.14
40	1st – 07th Oct	8.20	7.68	9.76	8.16	8.98	7.92	16.52	15.20	14.72	15.08	15.62	15.14
41	8th – 14th Oct	7.60	3.88	4.48	3.52	6.04	3.70	14.36	16.56	14.32	16.24	14.34	16.40
42	15th – 21st Oct	4.60	3.20	2.92	2.36	3.76	2.78	13.24	13.96	12.28	13.60	12.76	13.78
43	22nd – 28th Oct	2.64	1.76	3.08	2.68	2.86	2.22	13.72	12.04	10.08	9.76	11.90	10.90
44	29th – 04th Nov	2.32	1.48	2.68	3.20	2.50	2.34	7.24	6.20	6.04	8.40	6.64	7.30
45	5th –11th Nov	3.64	4.32	5.64	6.20	4.64	5.26	5.72	3.32	3.88	2.76	4.80	3.04
46	12th – 18th Nov	6.84	8.20	10.28	12.00	8.56	10.10	5.08	4.12	2.92	3.04	4.00	3.58
47	19th – 25th Nov	5.64	5.72	8.48	10.88	7.06	8.30	7.52	5.00	2.64	2.08	5.08	3.54
48	26th – 02nd Dec	3.52	4.92	4.80	6.64	4.16	5.78	4.44	5.96	1.84	1.68	3.14	3.82
49	3rd – 09th Dec	2.28	2.48	5.64	2.88	3.96	2.68	1.56	1.80	1.12	1.44	1.34	1.62
50	10th – 16th Dec	1.88	1.48	1.52	1.08	1.70	1.28	1.80	1.84	1.24	0.44	1.52	1.14
51	17th – 23rd Dec	1.04	1.36	1.16	1.28	1.10	1.32	2.12	0.96	1.48	0.36	1.80	0.66
52	24th – 31st Dec	0.60	0.88	0.44	1.32	0.52	1.10	1.20	0.56	0.92	1.24	1.06	0.90
Range		0.60-40.96	0.36-62.52	0.44-43.36	0.08-43.96	0.52-42.16	0.22-59.32	0.28-16.96	0.16-17.24	0.28-14.72	0.36-16.24	0.28-15.62	0.26-16.40
Mean±SD		8.97±10.85	11.18±16.46	10.18±11.56	10.97±14.71	9.57±11.01	11.08±15.55	6.84±5.75	6.32±6.07	5.25±5.22	5.74±5.51	6.05±5.45	6.03±5.72
		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

SMW- Standard meteorological week

Table 2: Seasonal incidence of thrips, *Thrips tabaci* and whiteflies, *Bemisia tabaci* on *Bt* and non-*Bt* cotton under unprotected condition during 2013 and 2014.

SMW	Periods	Population of thrips (Nos) /3 leaves						Population of whiteflies (Nos) /3 leaves					
		2013		2014		2013 & 2014		2013		2014		2013 & 2014	
		Bt	N-*Bt*	*Bt*	N-*Bt*	Mean (*Bt*)	Mean (N-*Bt*)	*Bt*	N-*Bt*	*Bt*	N-*Bt*	Mean (*Bt*)	Mean (N-*Bt*)
32	6th – 12th Aug	0.08	0.16	0.00	0.00	0.04	0.08	0.16	0.24	0.64	0.44	0.40	0.34
33	13th – 19th Aug	0.60	0.32	0.16	0.60	0.38	0.46	0.28	0.48	0.72	0.64	0.50	0.56
34	20th – 26th Aug	1.28	1.24	1.00	1.60	1.14	1.42	0.84	0.88	1.00	1.52	0.92	1.20
35	27th – 02nd Sep	1.64	2.56	1.80	3.08	1.72	2.82	1.48	1.76	1.88	2.48	1.68	2.12
36	3rd – 09th Sep	0.68	1.60	0.72	2.36	0.70	1.98	1.96	1.84	2.08	2.56	2.02	2.20
37	10th – 16th Sep	1.52	1.24	1.76	1.68	1.64	1.46	1.20	1.48	1.64	2.20	1.42	1.84
38	17th – 23rd Sep	1.72	1.84	2.12	2.36	1.92	2.10	0.64	2.00	0.48	2.56	0.56	2.28
39	24th – 30th Sep	1.64	1.48	1.76	1.64	1.70	1.56	3.12	2.64	2.76	3.72	2.94	3.18
40	1st – 07th Oct	2.04	2.16	1.84	2.04	1.94	2.10	3.68	3.32	4.04	3.96	3.86	3.64
41	8th – 14th Oct	2.40	1.92	2.24	1.76	2.32	1.84	5.48	4.92	5.96	5.88	5.72	5.40
42	15th – 21st Oct	1.44	1.68	1.84	1.56	1.64	1.62	4.44	4.24	5.40	5.24	4.92	4.74
43	22nd – 28th Oct	0.56	0.60	0.76	0.40	0.66	0.50	3.68	3.96	3.88	3.56	3.78	3.76
44	29th – 04th Nov	0.64	1.12	0.44	0.88	0.54	1.00	2.80	2.12	3.48	2.92	3.14	2.52
45	5th –11th Nov	0.60	0.36	0.68	0.48	0.64	0.42	1.64	1.44	1.88	2.24	1.76	1.84
46	12th – 18th Nov	0.24	0.16	0.56	0.08	0.40	0.12	0.56	1.52	0.60	2.16	0.58	1.84
47	19th – 25th Nov	0.28	0.00	0.72	0.00	0.50	0.00	1.04	1.48	1.24	1.92	1.14	1.70
48	26th – 02nd Dec	0.00	0.00	0.08	0.00	0.04	0.00	0.84	1.16	1.04	1.24	0.94	1.20
49	3rd – 09th Dec	-	-	-	-	-	-	0.36	1.04	0.28	0.76	0.32	0.90
50	10th – 16th Dec	-	-	-	-	-	-	0.40	1.28	0.64	0.92	0.52	1.10
51	17th – 23rd Dec	-	-	-	-	-	-	0.24	0.68	0.16	0.40	0.20	0.54
52	24th – 31st Dec	-	-	-	-	-	-	0.28	0.40	0.16	0.12	0.22	0.26
Range		0.00-2.44	0.00-2.56	0.00-2.24	0.00-3.08	0.04-2.32	0.00-2.82	0.16-5.48	0.24-4.92	0.16-5.96	0.12-5.88	0.20-5.72	0.26-5.40
Mean±SD		1.02±0.73	1.08±0.82	1.09±0.76	1.21±0.97	1.05±0.74	1.15±0.89	1.67±1.57	1.85±1.29	1.90±1.72	2.26±1.57	1.79±1.64	2.06±1.41
		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

SMW- Standard meteorological week

Table 3: Seasonal incidence of red cotton bug, *Dysdercus cingulatus* on *Bt* and non-*Bt* cotton under unprotected condition during 2013 and 2014.

Std. Week	Date	Red cotton bug (Nos /Plant)					
		2013		2014		2013 & 2014	
		Bt	N-*Bt*	*Bt*	N-*Bt*	Mean (*Bt*)	Mean (N-*Bt*)
42	15th – 21st Oct	1.28	1.72	0.84	1.08	1.06	1.40
43	22nd – 28th Oct	4.56	4.28	3.76	5.68	4.16	4.98
44	29th – 04th Nov	6.56	6.04	5.96	5.72	6.26	5.88
45	05th –11th Nov	7.08	6.88	6.68	7.04	6.88	6.96
46	12th – 18th Nov	7.24	7.44	6.92	6.72	7.08	7.08
47	19th – 25th Nov	7.44	7.84	6.52	7.24	6.98	7.54
48	26th – 02nd Dec	7.88	8.04	7.68	7.88	7.78	7.96
49	03rd – 09th Dec	5.36	6.16	5.12	6.36	5.24	6.26
50	10th – 16th Dec	5.16	5.76	5.48	4.92	5.32	5.34
51	17th – 23rd Dec	3.68	3.64	4.12	4.16	3.90	3.90
52	24th – 31st Dec	2.44	2.24	2.68	2.60	2.56	2.42
Range		1.28-7.88	1.72-8.04	0.84-7.68	1.08-7.88	1.06-7.78	1.40-7.96
Mean±SD		5.33 ±2.17	5.46 ±2.20	5.07 ±2.05	5.40±2.08	5.20 ±2.10	5.43 ±2.11
		NS	NS	NS	NS	NS	NS

SMW- Standard meteorological week

Table 4: Effect of weather parameters on incidence of the sucking pests on *Bt* and Non *Bt* cotton.

Meteorological Parameters	Simple correlation coefficient (r) between meteorological parameters and sucking pests population																			
	Aphids				Jassids				Thrips			Whiteflies						Red cotton bug		
	2013		2014		2013		2014		2013		2014	2013				2014		2013		2014
	Bt	N-*Bt*	*Bt*	N-*Bt*	*Bt*	N-*Bt*	*Bt*	N-*Bt*	*Bt*	N-*Bt*	*Bt*	N-*Bt*	*Bt*	N-*Bt*	*Bt*	N-*Bt*	*Bt*	N-*Bt*	*Bt*	N-*Bt*
Temp. (Max) (^{O}C)	0.502*	0.443*	0.533*	0.441*	0.375	0.370	0.185	0.271	0.544*	0.586*	0.306	0.610**	0.370	0.313	0.169	0.258	-0.132	-0.195	-0.132	-0.106
Temp. (Min) (^{O}C)	0.619**	0.546*	0.160	0.028	0.280	0.285	0.239	0.218	0.429	0.482*	-0.072	-0.206	0.180	0.075	0.246	0.278	-0.116	-0.172	0.157	0.280
Temp. (Mean) (^{O}C)	0.554**	0.488*	0.482*	0.372	0.365	0.362	0.215	0.281	0.549*	0.597*	0.261	0.508*	0.334	0.262	0.204	0.286	-0.142	-0.211	-0.024	0.044
R H (Morning) (%)	0.356	0.304	0.483*	0.491*	0.533**	0.544*	0.144	0.257	0.375	0.290	0.137	0.445	0.530*	0.554*	0.165	0.220	0.150	0.103	-0.193	-0.141
R H (Evening) (%)	0.417	0.366	0.409	0.435*	0.567**	0.575**	0.132	0.261	0.285	0.228	0.161	0.464	0.499*	0.569**	0.203	0.261	0.283	0.238	-0.110	-0.068
R H (Mean) (%)	0.395	0.343	0.454 *	0.471*	0.560**	0.570**	0.140	0.265	0.338	0.266	0.155	0.469	0.522*	0.571**	0.190	0.248	0.226	0.180	-0.148	-0.101
Rain fall (mm)	0.178	0.215	0.642**	0.685**	0.332	0.354	0.047	0.199	0.235	0.219	0.195	0.577*	0.307	0.288	0.003	0.096	-0.118	-0.178	-0.701*	-0.536
P=0.05	0.433				0.433				0.482				0.433				0.602			
P=0.01	0.549				0.549				0.606				0.549				0.735			

* Significant at P= 0.05, ** Significant at P=0.01, NS= Not significant

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