



# **Population Dynamics of Aphid, *Aphis gossypii* Glover on *Bt* and non-*Bt* Cotton and Correlation with weather Parameters**

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## **Authors' contributions**

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

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## **ABSTRACT**

Investigations on the population dynamics of aphid *Aphis gossypii* Glover on *Bt* (G.Cot.Hy.8 BG II) and non-*Bt* (G.Cot.Hy.8) were carried out at Main Cotton Research Station, Navsari Agricultural University, Surat, Gujarat during the *Kharif*, 2020-21. The incidence of aphids initiated in the first week of July (27<sup>th</sup> SW) in *Bt* cotton hybrid and in the second week of July (28<sup>th</sup> SW) in non-*Bt* cotton hybrid and continued till the crop harvest in the second week of January (2<sup>nd</sup> SW) in both the hybrids. The peak activity of aphids was recorded during the third week of December (51<sup>st</sup> SW) in *Bt* as well as non-*Bt* cotton hybrid. In both *Bt* and non-*Bt* cotton, the aphid population had a significant negative correlation with morning relative humidity. There was a highly significant negative correlation with minimum temperature, evening relative humidity, rainfall, rainy days, and a positive correlation with sunshine hours.

**Keywords:** *Aphis gossypii*; *Bt* and non-*Bt* cotton; correlation; population dynamics.

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## 1. INTRODUCTION

Cotton, *Gossypium hirsutum* (L.) is the most important cash crop in over 60 countries around the world. India is the largest producer and exporter of cotton yarn. Cotton is one of the most important cash crops as textile industries play a key role (5% of GDP) in the economy of India [1]. The total crop production was recorded at 113.32 million bales from 32.20 million hectares of total cultivated area with the productivity of 766 kg/ha in the world. The production of cotton was 29.00 million bales from the 13.35 million hectares of cultivated area and the productivity was 473 kg/ha in India [2]. The major cotton producing states are Gujarat, Maharashtra, Telangana, Andhra Pradesh, Karnataka, Madhya Pradesh, Haryana, Rajasthan and Punjab in India. The introduction of transgenic *Bt* cotton for commercial cultivation in India in 2002 has become a boon to the cotton growing farmers and protected the crops from bollworm damage and saved yield losses. The damage caused by insect pests is the major cause of loss in cotton quality, net profit and higher cost of production. The spectrum of cotton is quite complex and as many as 200 species of insects have been recorded as pests in the cotton of different crop growth in India [3]. Among various insect pests infesting the cotton crop, *Aphis gossypii* (Hemiptera: Sternorrhyncha: Aphididae) is a major pest of cotton causing heavy loss in the yield of cotton. Aphid is also known as “plant louse, greenfly or ant cow” [4]. It is a small, yellow to dark green, polyphagous pest and has the ability to cause serious damage. The nymphs and adults of *A. gossypii* feed on the plant sap which causes crumpling and downward curling of leaves and sticky cotton due to the deposit of honeydew like substance on leaves and bolls [5]. They are adapted to a wide range of environmental conditions and can easily spread. The study on population dynamics helps in decision-making for the timely application of various control measures. *A. gossypii* is a major pest of the crop. Therefore, the present investigation was carried out on the population dynamics of aphids in *Bt* and non-*Bt* cotton. Due to the continuous changing atmospheric patterns, the correlation of the aphid population with the weather parameters was also studied.

## 2. MATERIALS AND METHODS

In order to study the population dynamics and impact of weather parameters on the incidence of aphids in *Bt* and non-*Bt* cotton, a field

experiment was carried out on short to medium duration hybrids namely, G.Cot.Hy.8 BG II *Bt* and G.Cot.Hy.8 non-*Bt* which are widely cultivated in South Gujarat region. The field trials were conducted at the Main Cotton Research Station, Navsari Agricultural University, Surat (Gujarat) during *Kharif*, 2020-21. The population of aphids (nymphs and adults) was recorded from three leaves (each from the top, middle and bottom canopy) on fifty randomly selected plants. Observations were recorded during morning hours (between 8 to 10 AM) on account of a low movement helping in assessing population counts. The observations were recorded at weekly intervals from seven days after germination till harvest. For recording observations, the whole plot was divided into ten equal quadrates and five plants were selected randomly in each quadrate. Plots were kept completely free from any insecticidal spray during the whole cropping season. In order to study the instantaneous effect of weather parameters on the population fluctuation of *A. gossypii*, the weekly observations on the nymphal and adult population were averaged and correlated with the physical factors of environment viz., maximum ( $T_{Max}$ ) and minimum ( $T_{Min}$ ) temperature, morning [RH (m)] and evening [RH (e)] relative humidity, bright sunshine hours (BSSH), rainfall and rainy days. The weekly data on various weather parameters were obtained from the Meteorology Observatory, Main Cotton Research Station, Navsari Agricultural University, Surat during *Kharif*.

## 3. RESULTS AND DISCUSSION

### 3.1 Population Dynamics of Aphid, *A. gossypii* on *Bt* Cotton

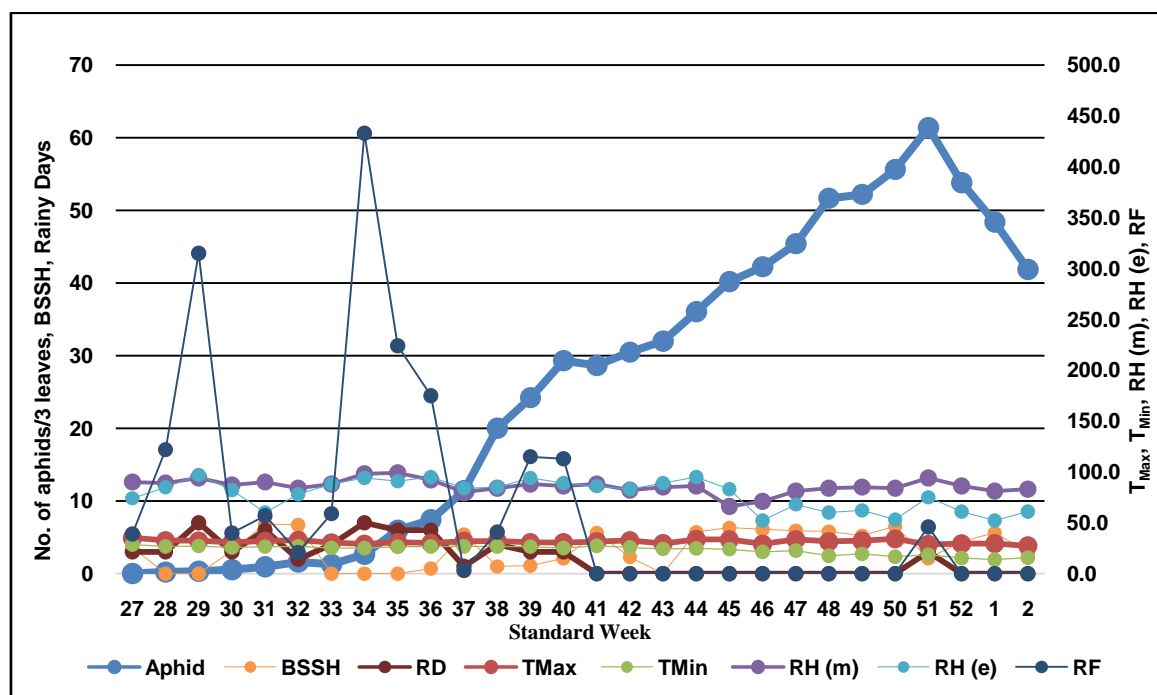
The population buildup of *A. gossypii* and its relation with the weather parameters on *Bt* cotton hybrid (G.Cot.Hy.8 BG II) are summarized in Table 1 and illustrated in Fig. 1. The pest was observed from the first week of July (27<sup>th</sup> SW) and continued till the crop harvest in the second week of January (2<sup>nd</sup> SW). *A. gossypii* population ranged between 0.16 to 74.28 aphids/3 leaves on *Bt* cotton. The population of aphids increased gradually to the third week of September (38<sup>th</sup> SW). The first peak was observed in the first week of December (49<sup>th</sup> SW) with 72.44 aphids/3 leaves. The second peak (74.28 aphids/3 leaves) was observed during the third week of December (51<sup>st</sup> SW). The incidence of aphids was observed above the economic threshold level (ETL – 10

aphids/leaf) from the fourth week of September (39<sup>th</sup> SW) to the second week of January (2<sup>nd</sup> SW). The population of aphids gradually decreased (64.38 aphids/3 leaves) from the fourth week of December (52<sup>nd</sup> SW) to the second week of January (48.60 aphids/3 leaves). In line with the present findings, Patel et al. [6] noted the highest population of aphids during the 50<sup>th</sup> SW (2<sup>nd</sup> week of December) [6]. Prasad et al. [7] noticed the maximum population from the second week of August to the second week of January (33<sup>rd</sup> to 2<sup>nd</sup> standard week) [7]. Soujanya et al. [8] recorded the first infestation of aphids was on the 34<sup>th</sup> standard week (4<sup>th</sup> week of August) and the highest population was observed during the 39<sup>th</sup> standard week (4<sup>th</sup> week of September) to the 46<sup>th</sup> standard week (3<sup>rd</sup> week of November) [8]. Muchhadiya et al. [9] reported that the aphid population was found to

damage the *Bt* cotton throughout the season however, the peak activity was found on 51<sup>st</sup> SW (3<sup>rd</sup> week of December) [9]. Nagendra (2015) reported the aphid infestation started during 32<sup>nd</sup> SW with the peak (41.4 aphids/3 leaves) population during 36<sup>th</sup> SW [10]. Bhandari et al. [11] reported the peak activity of aphids during the 48<sup>th</sup> SW (4<sup>th</sup> week of November) with 61.20 aphids/3 leaves on cotton crop [11]. According to Boda and Ilyas [12], aphid incidence was started during the fourth week of July (30<sup>th</sup> SW) and the maximum (73.40 aphids/3 leaves) population was recorded in the first week of October (40<sup>th</sup> SW) [12]. Nemade et al. [13] found that the maximum aphid population (43.56%) was recorded in the second week of August (33<sup>rd</sup> SW), which is different from the present findings [13].

**Table 1. Population dynamics of aphid, *A. gossypii* in *Bt* and non-*Bt* cotton**

Sr. No.	Standard Week (SW)	Weeks of Month	No. of aphids/3 leaves	
			<i>Bt</i> cotton (G.Cot.Hy.8 BG II)	Non <i>Bt</i> cotton (G.Cot.Hy.8)
1	27	02 July – 08 July	0.16	0.00
2	28	09 July – 15 July	0.40	0.20
3	29	16 July – 22 July	0.66	0.32
4	30	23 July – 29 July	0.94	0.54
5	31	30 July – 05 August	1.20	0.94
6	32	06 August – 12 August	2.40	1.60
7	33	13 August – 19 August	1.96	1.26
8	34	20 August – 26 August	3.82	2.66
9	35	27 August – 02 Sept.	8.66	5.98
10	36	03 Sept. – 09 Sept.	12.42	7.40
11	37	10 Sept. – 16 Sept.	16.80	11.42
12	38	17 Sept. – 23 Sept.	24.96	20.02
13	39	24 Sept. – 30 Sept.	32.42	24.22
14	40	01 Oct. – 07 Oct.	35.68	29.30
15	41	08 Oct. – 14 Oct.	32.72	28.66
16	42	15 Oct. – 21 Oct.	36.42	30.48
17	43	22 Oct. – 28 Oct.	36.86	32.00
18	44	29 Oct. – 04 Nov.	42.44	36.06
19	45	05 Nov. – 11 Nov.	48.68	40.20
20	46	12 Nov. – 18 Nov.	50.22	42.24
21	47	19 Nov. – 25 Nov.	53.86	45.42
22	48	26 Nov. – 02 Dec.	66.88	51.68
23	49	03 Dec. – 09 Dec.	72.44	52.20
24	50	10 Dec. – 16 Dec.	68.48	55.64
25	51	17 Dec. – 23 Dec.	74.28	61.40
26	52	24 Dec. – 31 Dec.	64.38	53.80
27	01	01 Jan. – 07 Jan.	56.52	48.40
28	02	08 Jan. – 14 Jan.	48.60	41.88
<b>Mean</b>			<b>31.97</b>	<b>25.93</b>



**Fig. 1. Population dynamics of aphid, *A. gossypii* in relation to weather parameters on *Bt* cotton**

The results on the correlation between the incidence of *A. gossypii* and different weather parameters revealed that minimum temperature ( $r = -0.803^{**}$ ), evening relative humidity ( $r = -0.577^{**}$ ), rainfall ( $r = -0.529^{**}$ ) and rainy days ( $r = -0.716^{**}$ ) showed a highly significant negative association with the population of *A. gossypii*. Morning relative humidity ( $r = -0.425^*$ ) showed a significant negative correlation with the aphid population. However, sunshine hours ( $r = 0.439^*$ ) had a significant positive correlation with the incidence of aphids infesting *Bt* cotton hybrid. These findings are in accordance with those of Sarode et al. [14] who noticed a significant negative correlation between aphid population buildup with the rainfall ( $r = -0.404^*$ ) and

maximum temperature ( $r = -0.574^*$ ) [14]. Prasad et al. [7] revealed that maximum temperature, minimum temperature, evening relative humidity and rainfall showed a significant negative correlation with the aphid population [7]. According to Muchhadiya et al. [9] aphids population showed a significant positive correlation with sunshine hours and a significant negative association with rainfall [9]. Likewise, Bhandari et al. [11] reported that the aphid population on *Bt* cotton was highly significant and negatively correlated with minimum temperature ( $r = -0.819^{**}$ ) and morning relative humidity ( $r = -0.760^{**}$ ) which are also in accordance with the present findings [11].

**Table 2. Correlation between the incidence of *A. gossypii* and weather parameters on *Bt* and non *Bt* cotton**

Weather parameters	Correlation co-efficient (r)	
	<i>Bt</i> cotton (G.Cot.Hy.8 BG II)	Non- <i>Bt</i> cotton (G.Cot.Hy.8)
Maximum Temperature, °C ( $T_{Max}$ )	-0.148	-0.164
Minimum Temperature, °C ( $T_{Min}$ )	-0.803**	-0.808**
Morning Relative Humidity, % RH (m)	-0.425*	-0.439*
Evening Relative Humidity, % RH (e)	-0.577**	-0.580**
Bright Sunshine Hours (BSSH)	0.439*	0.441*
Rainfall (mm)	-0.529**	-0.541**
Rainy days (no.)	-0.716**	-0.731**

\*\*Significant at the  $P < 0.01$  level; \* Significant at the  $P < 0.05$  level

### 3.2 Population Dynamics of Aphid, *A. gossypii* on Non-Bt Cotton

The population buildup of *A. gossypii* and its relation with the weather parameters on non-Bt cotton hybrid (G.Cot.Hy.8 non-Bt) is summarized in Table 1 and illustrated in Fig. 2. *A. gossypii* appeared in the second week of July (28<sup>th</sup> SW) and continued till the harvest in the second week of January (2<sup>nd</sup> SW) on the non-Bt cotton hybrid. The population ranged between 0.20 to 61.40 aphids/3 leaves. The population of aphids increased slowly up to the second week of October (41<sup>st</sup> SW). The peak population was observed in the third week of December (51<sup>st</sup> SW) with 61.40 aphids/3 leaves, which was the highest population recorded in the experiment. The population of aphids gradually decreased (53.80 aphids/3 leaves) from the fourth week of December (52<sup>nd</sup> SW) to the second week of January (48.60 aphids/3 leaves). Thus, it is clear from the data that relatively higher activity (30.48 to 61.40 aphids/3 leaves) was observed from the third week of October to the third week of December. Similar findings are also stated by Laxman et al. [15] who observed that the incidence of aphids reached a maximum during the first week of December (>43 aphids/3 leaves) and after the gradually population decreased [15]; Bhanderi et al. [11] found the peak activity of aphid during 48<sup>th</sup> SW (4<sup>th</sup> week of November)

with 76.25 aphids/3 leaves on Desi Cotton Hybrid (DCH) 32 non-Bt cotton [11]. According to Mohapatra [16], the first appearance of the aphid population was observed from the 4<sup>th</sup> week of July (30<sup>th</sup> SW) to the 2<sup>nd</sup> week of December (50<sup>th</sup> SW) with peak population recorded during the 35<sup>th</sup> SW (4<sup>th</sup> week of August) in non-Bt cotton [16]. Soujanya et al. [8] observed the initial aphid population started on 34<sup>th</sup> SW (4<sup>th</sup> week of August) and the peak incidence was observed from 39<sup>th</sup> SW (4<sup>th</sup> week of September) to 46<sup>th</sup> standard week (3<sup>rd</sup> week of November) [8]. Panwar et al. [17] revealed that aphid incidence started in 34<sup>th</sup> SW and remained throughout the season [17]. According to Sathyan et al. [18] the highest aphid population was observed during the 50<sup>th</sup> SW (2<sup>nd</sup> week of December), the 3<sup>rd</sup> SW (3<sup>rd</sup> week of January) and the 4<sup>th</sup> SW (4<sup>th</sup> week of January) [18]. But the result is not confirmation by the finding of Patel [19], who noticed aphid peak population (32.33 aphids/3 leaves) during the 33<sup>rd</sup> SW (2<sup>nd</sup> week of August) [19]. Thus, the above reports of Mohapatra [16], Soujanya et al. [8], Laxman et al. [15], Panwar et al. [17], Bhanderi et al. [11] and Sathyan et al. [18] are in accordance with the present investigation. However, the reports of Patel [19] and Sarode et al. [14] do not tally with the present findings might be due to different locations, sowing times and climatic conditions.

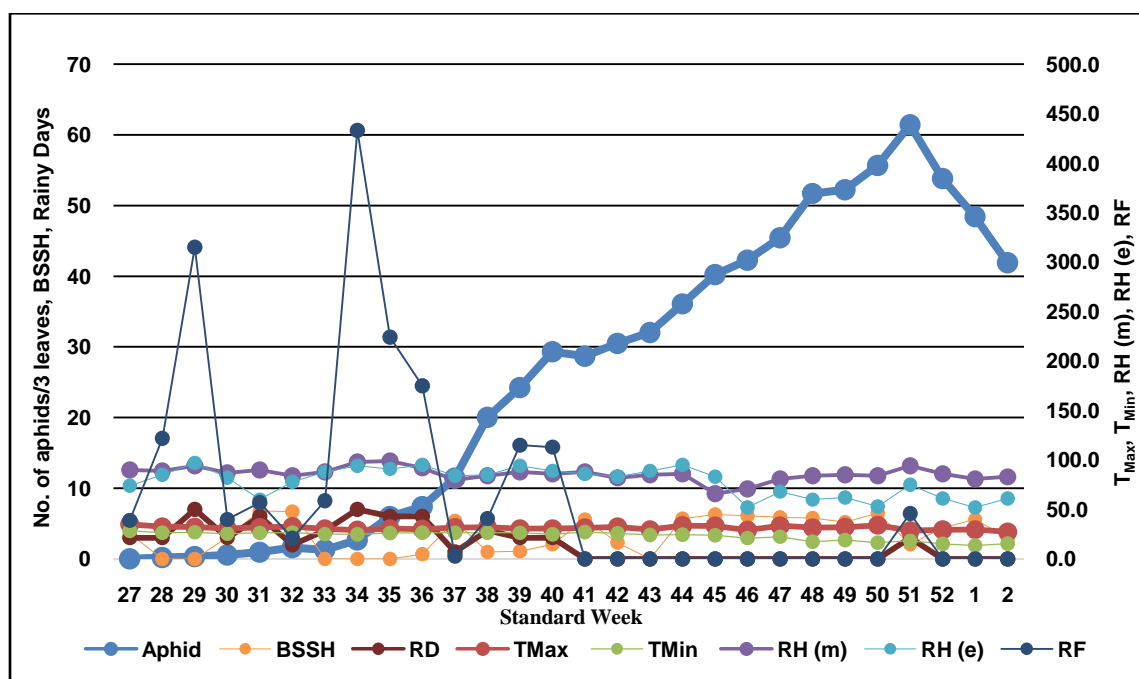


Fig. 2. Population dynamics of aphid, *A. gossypii* in relation to weather parameters on non-Bt cotton

In non-*Bt* cotton, minimum temperature ( $r = -0.808^{**}$ ), evening relative humidity ( $r = -0.580^{**}$ ), rainfall ( $r = -0.541^{**}$ ) and rainy days ( $r = -0.731^{**}$ ) showed highly significant negative association with the aphid population. Maximum temperature ( $r = -0.164$ ) had non-significant negative association. Morning relative humidity ( $r = -0.439^*$ ) had a significant negative correlation with the aphid population. However, bright sunshine hours ( $r = 0.441^*$ ) had a significant positive correlation with the incidence of aphids infesting non-*Bt* cotton. The present findings are in accordance with Panwar et al. [17] revealed that the correlation was significant and negative between aphid population in maximum temperature ( $r = -0.546^*$ ), minimum temperature ( $r = -0.577^*$ ) and morning relative humidity ( $r = -0.588^*$ ) [17]. Bhanderi et al. [11] stated that the aphid population in non-*Bt* cotton was highly significant and negatively correlated with minimum temperature and morning relative humidity [11].

#### 4. CONCLUSION

The peak population of *A. gossypii* was observed during the third week of December (5<sup>1</sup><sup>st</sup> SW) on *Bt* and non-*Bt* cotton. The peak activity of aphid *Bt* hybrid was recorded higher (31.97 aphids/3 leaves) on *Bt* cotton hybrid compared to non-*Bt* cotton hybrid (25.93 aphids/3 leaves). The morning relative humidity had a significant negative association whereas minimum temperature, evening relative humidity, rainfall and rainy days had a highly significant negative correlation with the aphid population. Sunshine hours had a significant positive correlation with the incidence of aphids on *Bt* as well as non-*Bt* cotton hybrid.

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#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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