Population Dynamics of aphid,*Aphis gossypii*Gloveron*Bt*and non-*Bt*cotton andcorrelationwithweather parameters

ABSTRACT

Investigations on thepopulation dynamics of aphid *Aphis gossypii*Gloveron *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 aphidsinitiated in the first week of July (27thSW) in *Bt*cotton hybrid and in the second week of July (28thSW) in non-*Bt*cotton hybrid and continued till the crop harvest in the second week of January (2ndSW)in both thehybrids. The peak activity of aphids was recorded during the third week of December (51stSW)in *Bt*as well as non-*Bt*cotton hybrid. In both *Bt* and non-*Bt* cotton, the aphid populationhad 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, Btand*non*-Bt cotton, correlation, population dynamics*

1. INTRODUCTION

Cotton,*Gossypiumhirsutum*(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 infestingthecotton crop, *Aphisgossypii(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-makingfor the timelyapplication of various control measures. *A. gossypii*is a major pest of the crop. Therefore, the present investigation was carried out onthe 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 theMain 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 croppingseason.In order to study the instantaneous effect of weather parameters on thepopulation fluctuation of *A. gossypii,* the weekly observations on the nymphal and adult population were averaged and correlated with thephysical 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

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) aresummarized in Table 1 and illustrated in Figure 1. The pest was observed from the first week of July (27thSW) and continued till the crop harvest in the second week of January (2ndSW). *A.gossypii*population ranged between 0.16 to 74.28 aphids/3 leaves on*Bt*cotton. The population of aphids increased graduallyto the third week of September (38th SW). The first peak was observed in the first week of December (49th SW) with 72.44 aphids/3 leaves. The second peak (74.28 aphids/3 leaves) was observed during the third week of December (51stSW). The incidence of aphids was observed above the economic threshold level (ETL – 10 aphids/leaf) from the fourth week of September (39thSW) to the second week of January (2ndSW). The population of aphids gradually decreased (64.38 aphids/3 leaves) from the fourth week of December (52ndSW) to the second week of January (48.60 aphids/3 leaves). In line with the present findings,Patel *et al.* (2016) notedthe highest population of aphids during the 50thSW (2nd week of December) [6].Prasad *et al*. (2008) noticed the maximum population from the second week of August to the second week of January (33rd to 2ndstandard week) [7].Soujanya*et al.* (2010) recorded the first infestation of aphids was on the 34th standard week (4th week of August) and the highest population was observed during the 39th standard week (4th week of September) to the 46th standard week (3rd week of November) [8]. Muchhadiya*et al.* (2014) reported that the aphid population was found to damage the *Bt* cotton throughout the season however, the peak activity was found on 51stSW (3rd week of December) [9].Nagendra (2015) reported the aphid infestation started during 32ndSW with the peak (41.4 aphids/3 leaves) population

during 36thSW [10].Bhanderi*et al.* (2016) reportedthe peak activity of aphids during the 48thSW (4th week of November) with 61.20 aphids/3 leaveson cotton crop [11].According to Boda and Ilyas (2017), aphid incidence was started during the fourth week of July (30thSW) and the maximum (73.40 aphids/3 leaves) population was recorded in the first week of October (40thSW) [12].Nemade*et al.* (2018) found that the maximum aphid population (43.56%) was recorded in the second week of August (33rdSW), which is different fromthe 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	
			***Bt*cotton (G.Cot.Hy.8 BG II)**	**Non *Bt*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
Mean			**31.97**	**25.93**

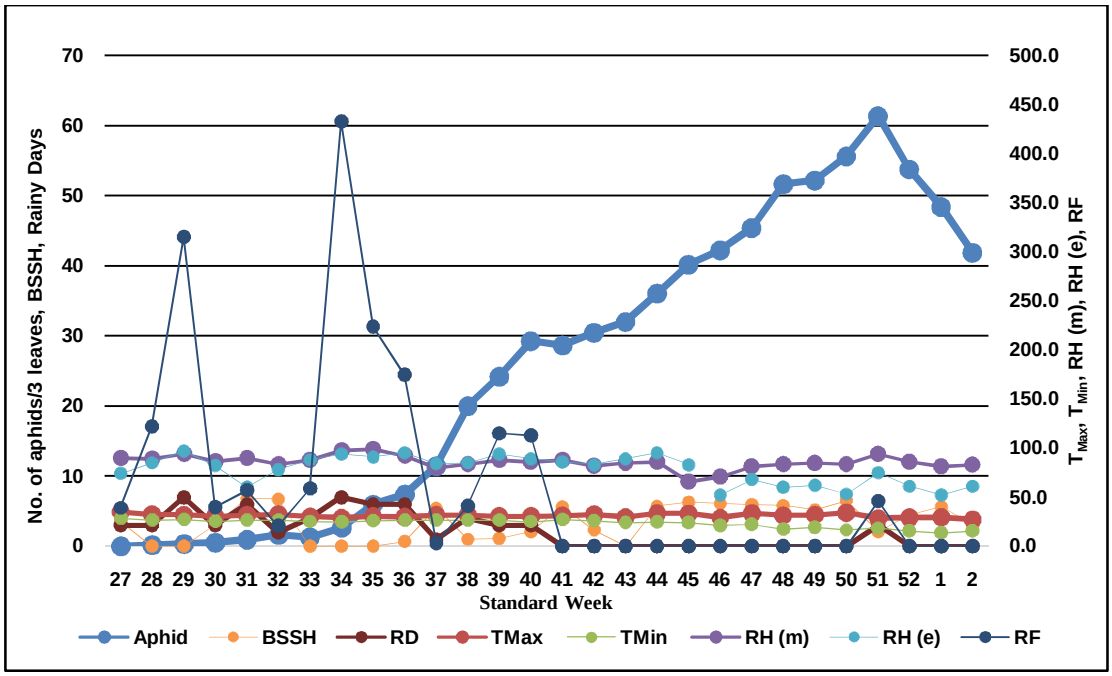

Fig. 1: Population dynamics of aphid, *A. gossypii*in relation to weather parameterson *Bt* cotton

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.* (2020) who noticeda significant negative correlation between aphid population buildupwith the rainfall (r= -0.404*) and maximum temperature (r = -0.574*) [14]. Prasad *et al.* (2008) 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.* (2014) aphids population showed a significant positive correlation with sunshine hours and a significant negative association with rainfall [9]. Likewise,Bhanderi*et al.* (2016) 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)	
	***Bt* cotton (G.Cot.Hy.8 BG II)**	**Non-*Bt* cotton (G.Cot.Hy.8)**

Maximum Temperature, ^{o}C (T_{Max})	-0.148	-0.164
Minimum Temperature, ^{o}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

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 Figure 2. *A. gossypii* appeared in the second week of July (28thSW) and continued till the harvest in the second week of January (2ndSW)onthenon-*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 (41stSW). The peak population was observed in the third week of December (51stSW) 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 (52ndSW) 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) wasobserved fromthe third week of October to the third week of December.Similar findings are also stated by Laxman*et al.* (2013) 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.* (2016) found the peak activity of aphid during 48thSW (4th week of November) with 76.25 aphids/3 leaves on Desi Cotton Hybrid (DCH) 32 non-*Bt*cotton [11]. According to Mohapatra (2008), the first appearance of the aphid population was observed from the 4th week of July (30thSW) to the 2nd week of December (50thSW) with peak population recorded during the 35thSW (4th week of August) in non-*Bt* cotton [16].Soujanya*et al.* (2010) observed the initial aphid population started on 34thSW (4th week of August) and the peak incidence was observed from 39thSW (4th week of September) to 46th standard week (3rd week of November) [8].Panwar*et al.* (2015) revealed that aphid incidence started in 34thSW and remained throughout the season [17]. According to Sathyan*et al.* (2018) the highest aphid population was observed during the 50thSW (2nd week of December), the 3rdSW (3rd week of January) and the 4thSW (4th week of January) [18].But the result is not confirmation by the finding of Patel (2013), who noticed aphid peak population (32.33 aphids/3 leaves) during the 33rdSW (2nd week of August) [19]. Thus, the above reports of Mohapatra (2008), Soujanya*et al.* (2010), Laxman*et al.* (2013), Panwar*et al.* (2015), Bhanderi*et al.* (2016) andSathyan*et al.* (2018) are in accordance with the present investigation. However, the reports of Patel (2013) and Sarode*et al.* (2020) do not tally with the present findings might be due to different locations, sowing times and climatic conditions.

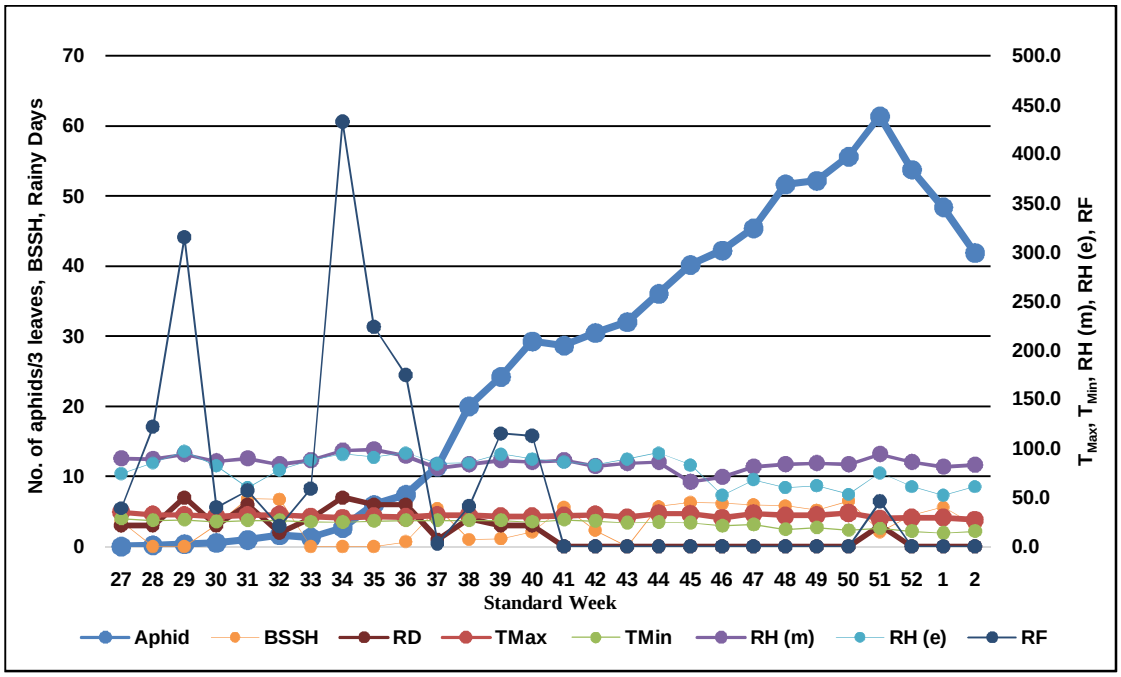

Fig. 2: Population dynamics of aphid, *A. gossypii*in relation to weather parameters on non-*Bt* cotton

In non-*Bt* cotton, minimum temperature (r = -0.808**), evening relative humidity (r = -0.580**), rainfall (r = -0.541**), 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.* (2015) 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.* (2016) 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 (51stSW) on*Bt*and non-*Bt*cotton. The peakactivity of aphid*Bt* hybrid was recorded higher (31.97 aphids/3 leaves) on Bt cotton hybridcompared 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.

Author's contribution

Designing of the experiment; field observations; weather data collection; analysis of data and preparation of the manuscript.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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