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Population dynamics of aphid *Aphis gossypii* (Glover) (Homoptera: Aphididae) on popular cotton hybrids in Telangana

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Abstract
The present study aimed at the screening of popular *Bt* cotton hybrids against aphid, *Aphis gossypii* (Glover) incidence at College farm, College of Agriculture, Rajendranagar, Hyderabad during *kharif* 2019-20. Eight transgenic cotton hybrids (Bioseed-7215-2, MH-5343, RCH-668, MRC-7347, PRCH-331, RCH-386, ROHINI-456, RCH-659) were sown and maintained without application of any insecticide till the maturity of the crop. Field data of aphids were collected from the occurrence of the pests after seedling emergence to till the harvest at weekly intervals. The results revealed that 34th, 35th, 36th, 51st and 52nd standard weeks were the most favourable for aphid incidence. The peak incidence of aphid population (18.56/3 leaves/plant) was recorded during 34th standard week in RCH-659. In correlation studies, aphid population showed negative correlation with the majority of abiotic factors. Particularly, the aphid population showed a non-significant negative correlation with maximum temperature, relative humidity, rainfall while the positive correlation with minimum temperature in most of the hybrids. The multiple linear regression studies revealed that all the weather parameters together contribute 31 percent **(**R^2=0.31**)** of the total variation in the aphid population.

Keywords: Aphid, *Bt*-cotton, correlation, weather parameters

1. Introduction

Cotton is the important commercial crop of India. Natural fiber produced by cotton is an important component of the textile industry. It is under commercial cultivation to cater to the domestic consumption and export needs of about 111 countries in the world and hence called "King of fibers" or "White gold". It is popularly known as a friendly fiber because of its versatility, appearance, performance, and above all its natural comfort. India ranks second in global cotton production after china with the adaption of *Bt* transgenic cotton cultivars widely. It is the largest cotton growing country in the world occupying an area of 124.4 lakh ha with production and productivity of 370 lakh bales and 505.4 kg ha^{-1} respectively. In India, Telangana has the largest acreage of 18.97 lakh ha with production and productivity of 55 lakh bales and 492.8 kg ha^{-1}, respectively [1].

Currently, with the popularization of *Bt* cotton, lepidopteran pests such as *Helicoverpa armigera* and *Pectinophora gossypiella* have been successfully controlled [2, 3]. However, *Bt* toxins are ineffectual against phloem-feeding pests. After the introduction of transgenic cotton in India, sucking pests emerged out as a major constraint in cotton production. In spite of repeated use of insecticides, we are witnessing control failures which might be the signals of insecticide resistance in sucking pests of cotton.

For managing the sucking insect pests on *Bt* cotton farmers frequently rely on chemical control [4]. The use of chemical control is not only creating health hazards and ecological contamination but also developing the resistance in the insects and disturbing the balance between the forces of destruction (predators, parasitoids and pathogens) in agro-ecosystem [5, 6]. The occurrence and progress of all the insect pests are much dependent upon the customary environmental factors such as temperature, relative humidity and precipitation [7]. The activities of these insect pests fluctuate under erratic environmental conditions. The knowledge about the incidence of a pest during the cropping season and its possible dynamics help in designing pest management strategies [8]. To develop suitable integrated pest management practices close monitoring of the insect pest complex of *Bt* cotton is necessary. Thus, by keeping the above things in mind the present study was carried out to investigate the seasonal occurrence and peak activity of sucking insect pest of the cotton throughout the cotton growing season and its correlation with weather factors. This information on pest surveillance will be useful for devising suitable pest management strategies for researchers and farmers.

2. Material and Methods

The present investigation was carried out at College farm, College of Agriculture, Rajendranagar, Hyderabad during *kharif* 2019-20 to study the population dynamics of major sucking pests of cotton.

2.1 Method of observations

Eight popular *Bt* cotton hybrids *viz*., Bioseed-7215-2, MH-5343, RCH-668, MRC-7347, PRCH-331, RCH-386, ROHINI-456, RCH-659 were raised in an area of 1000 m^2 to study the seasonal incidence of aphids, *Aphis gossypii* (Glover) by adopting recommended agronomical practices without plant protection during *kharif* 2019-20. The observations were recorded on ten plants/replication randomly and the count was taken early in the morning by visual counting (absolute counting) on three leaves/plant (one each from the top, middle and bottom) using a magnifying lens from the first occurrence of the pest to till the last picking. Meteorological data were collected and analysis was done to arrive at a correlation and regression analysis equation between pest incidence and weather parameters.

2.2 Statistical Analysis

The data obtained was analyzed for ANOVA (5% probability level) following a randomized block design by using Microsoft excel software, further subjected to angular transformation. The means were compared by Duncan's Multiple Range Test (DMRT) at P = 0.05. A simple correlation was worked out, between the pest population and weather factors individually, by using a Multiple Linear Regression Equation of Type 1, viz., $Y= a+ b_1X_1+ b_2X_2 + b_3X_3+ b_4X_4……$ where the population of sucking pest was taken as the Response Variables (Y) and the weather factors (X) as independent variables in the equation. Where (a) and (b) are the intercept and regression coefficients respectively.

3 Results and Discussion

3.1 Aphids (*Aphis gossypii)*

Aphid population incidence during *kharif* 2019-20 (Table1 and figure 1) was recorded throughout the crop period (34th - 52nd Std. week) except during 40th, 41st, 42nd, 45th, 46th and 47th std. weeks in all the hybrids *viz*., Bioseed-7215-2, MH-5343, RCH-668, MRC-7347, PRCH-331, RCH-386, ROHINI-456 and RCH-659.The results revealed that 34th,35th, 36th, 51st and 52nd Std. weeks were the most favourable for aphid incidence.

The peak aphid population recorded during 34th std. week on all the test hybrids. The aphid population fluctuated between 7.96-18.56 aphids/3 leaves/plant. Highest aphid population recorded on RCH-659 (18.56) followed by RCH-668 (18.36), RCH-386 (16.33), Rohini-456 (14.36), MH-5343 (13.20), Bioseed-7215-2 (12.26), PRCH-331 (10.96) and MRC-7347 (7.96). Statistical analysis revealed that hybrids were significantly differed from each other and also with the popular check. Bioseed-7215-2, MH-5343, PRCH-331 and Rohini-456 differed significantly from other hybrids. Thereafter, aphid incidence was declined comparatively.

The correlation matrix worked out between aphid population and weather parameters from 34th std. week to 52nd std. week on different *Bt* hybrids revealed that the aphid population showed a negative correlation with the majority of abiotic factors. Particularly, nonsignificant negative correlation with maximum temperature, relative humidity, rainfall and positive correlation with minimum temperature in most of the hybrids (Table 1). The multiple linear regression analysis concluded that the major abiotic factors responsible for a maximum of 31 percent (R^2=0.31) variation in the aphid population (Table 2).

Present results conformed with the earlier reports of Senapati and Mohanty [9], Rao [10], Dheeraj Purohit *et al.* [11], Mohapatra [12], Gosalwad *et al.* [13], Shitole and Patel [14], Chavan *et al.* [15], Vanitha and Banu [16], Bhute *et al.* [17] and Harde *et al.* [18] where they concluded that the aphid incidence was highest during 4th week of August *i.e.* 35th and 50th days after sowing. Peak activity was observed from August to November on cotton during *kharif* depending on locality and weather parameters. Even the peak incidence continued up to December to January first fortnight (Phulse and Udikeri) [19]. Further, correlation studies concluded by (Sesha Mahalakshmi) [20], (Lakshmi Soujanya) [21], (Gosalwad *et al.*) [13], (Sitaramaraju) [22], (Shivanna *et al.*) [23], (Rohini 2010) [24], (Sitaramaraju *et al.*) [25], (Bhute *et al.*) [17], (Harde *et al.*) [18] revealed that maximum temperature, minimum temperature, relative humidity and rain fall showed negative and nonsignificant correlation on the population of aphids and abiotic factors all together were responsible for a total influence of 33.9 percent (R^2 value =0.339) in aphid population. So, the present results were by earlier finding.

Table 1: Aphid population incidence in different *Bt*-cotton hybrids during *Kharif* 2019-20

Hybrids	Meteorological standard weeks																		
	34th	**35th**	**36th**	**37th**	**38th**	**39th**	**40th**	**41st**	**42nd**	**43rd**	**44th**	**45th**	**46th**	**47th**	**48th**	**49th**	**50th**	**51st**	**52nd**
Bioseed-7215-2	12.26 (20.49)^{ab}	7.63 (15.71)^{ab}	4.66 (12.47)^{abc}	1.00 (5.70)^{ab}	0.10 (1.20)^{b}	2.76 (8.93)^{a}	0.00 (0.00)	0.13 (1.20)^{a}	0.00 (0.00)	0.13 (1.20)^{ab}	0.96 (4.57)^{a}	0.20 (1.48)^{a}	0.00 (0.00)	0.00 (0.00)	0.70 (4.79)^{ab}	2.50 (9.07)^{b}	3.26 (8.45)^{a}	5.93 (14.05)^{cd}	7.60 (15.91)^{a}
MH-5343	13.20 (21.06)^{ab}	11.2 (19.25)^{a}	5.40 (13.14)^{abc}	2.36 (7.98)^{a}	0.66 (4.38)^{a}	0.13 (1.20)^{bc}	0.00 (0.00)	0.00 (0.00)^{a}	0.00 (0.00)	0.33 (1.91)^{ab}	0.13 (1.71)^{abc}	0.00 (0.00)^{a}	0.00 (0.00)	0.00 (0.00)	1.10 (5.91)^{ab}	3.00 (9.90)^{ab}	1.56 (6.95)^{a}	6.83 (15.14)^{abcd}	3.93 (11.39)^{b}
RCH-668	18.36 (25.34)^{a}	4.63 (12.38)^{ab}	8.16 (16.37)^{a}	1.36 (6.31)^{ab}	0.16 (1.35)^{ab}	0.00 (0.00)^{c}	0.00 (0.00)	0.00 (0.00)^{a}	0.00 (0.00)	0.20 (1.48)^{ab}	0.63 (3.69)^{ab}	0.23 (1.60)^{a}	0.00 (0.00)	0.00 (0.00)	1.23 (6.31)^{ab}	2.53 (9.10)^{b}	1.46 (6.18)^{a}	4.73 (12.01)^{d}	4.23 (11.82)^{b}
MRC-7347	7.96 (16.03)^{b}	3.33 (10.33)^{b}	2.63 (9.30)^{c}	0.23 (2.69)^{b}	0.06 (0.85)^{b}	0.00 (0.00)^{c}	0.00 (0.00)	0.00 (0.00)^{a}	0.00 (0.00)	0.16 (1.90)^{b}	0.00 (0.00)^{c}	0.00 (0.00)^{a}	0.00 (0.00)	0.00 (0.00)	0.60 (4.28)^{b}	1.26 (6.40)^{c}	1.20 (5.62)^{a}	6.53 (14.75)^{bcd}	2.60 (9.2)^{c}
PRCH-331	10.96 (19.27)^{ab}	3.00 (9.93)^{b}	3.46 (10.58)^{bc}	2.26 (8.19)^{a}	0.13 (1.20)^{b}	0.13 (1.20)^{bc}	0.00 (0.00)	0.00 (0.00)^{a}	0.00 (0.00)	0.36 (2.75)^{ab}	0.03 (0.60)^{bc}	0.00 (0.00)^{a}	0.00 (0.00)	0.00 (0.00)	0.66 (3.82)^{b}	3.46 (10.70)^{ab}	1.00 (4.30)^{a}	9.23 (17.66)^{abc}	6.80 (15.10)^{a}
RCH-386	16.33 (23.79)^{a}	8.83 (16.85)^{ab}	4.10 (11.42)^{bc}	1.36 (6.54)^{ab}	0.2 (1.48)^{ab}	1.33 (5.30)^{ab}	0.00 (0.00)	0.00 (0.00)^{a}	0.00 (0.00)	0.10 (1.04)^{ab}	0.13 (1.65)^{abc}	0.10 (1.04)^{a}	0.00 (0.00)	0.00 (0.00)	2.90 (8.62)^{a}	3.26 (10.37)^{ab}	1.13 (4.97)^{a}	10.06 (18.44)^{ab}	4.46 (12.08)^{b}
ROHINI-456	14.36 (22.04)^{ab}	10.90 (18.62)^{ab}	6.33 (14.52)^{ab}	1.43 (6.77)^{ab}	0.26 (2.33)^{ab}	0.13 (1.20)^{bc}	0.00 (0.00)	0.00 (0.00)^{a}	0.00 (0.00)	0.00 (0.00)^{b}	0.13 (1.20)^{bc}	0.00 (0.00)^{a}	0.00 (0.00)	0.00 (0.00)	0.96 (5.54)^{ab}	2.46 (8.93)^{b}	1.33 (4.94)^{a}	6.93 (15.25)^{abcd}	6.40 (14.61)^{a}
RCH-659 (Check)	18.56 (25.37)^{a}	12.5 (19.82)^{a}	4.23 (11.74)^{bc}	1.46 (6.95)^{ab}	0.36 (3.44)^{ab}	0.4 (2.96)^{bc}	0.00 (0.00)	0.00 (0.00)^{a}	0.00 (0.00)	0.80 (4.05)^{a}	0.20 (1.95)^{abc}	0.00 (0.00)^{a}	0.00 (0.00)	0.00 (0.00)	1.36 (6.70)^{ab}	4.16 (11.75)^{a}	2.40 (7.91)^{a}	10.4 (18.77)^{a}	7.73 (16.06)^{a}

SEM	2.02	2.92	1.39	1.47	1.01	1.68	0.00	0.00	0.00	1.31	1.02	0.86	0.00	0.00	1.37	0.66	1.66	1.26	0.53
CD (0.05%)	6.13	8.86	4.21	4.48	3.06	5.09	0.00	1.29	0.00	3.98	3.12	2.62	0.00	0.00	4.17	2.02	5.04	3.85	1.63
CD (0.01%)	8.51	12.30	5.85	6.22	4.25	7.07	0.00	1.79	0.00	5.53	4.33	3.64	0.00	0.00	5.79	2.81	6.99	5.34	2.26

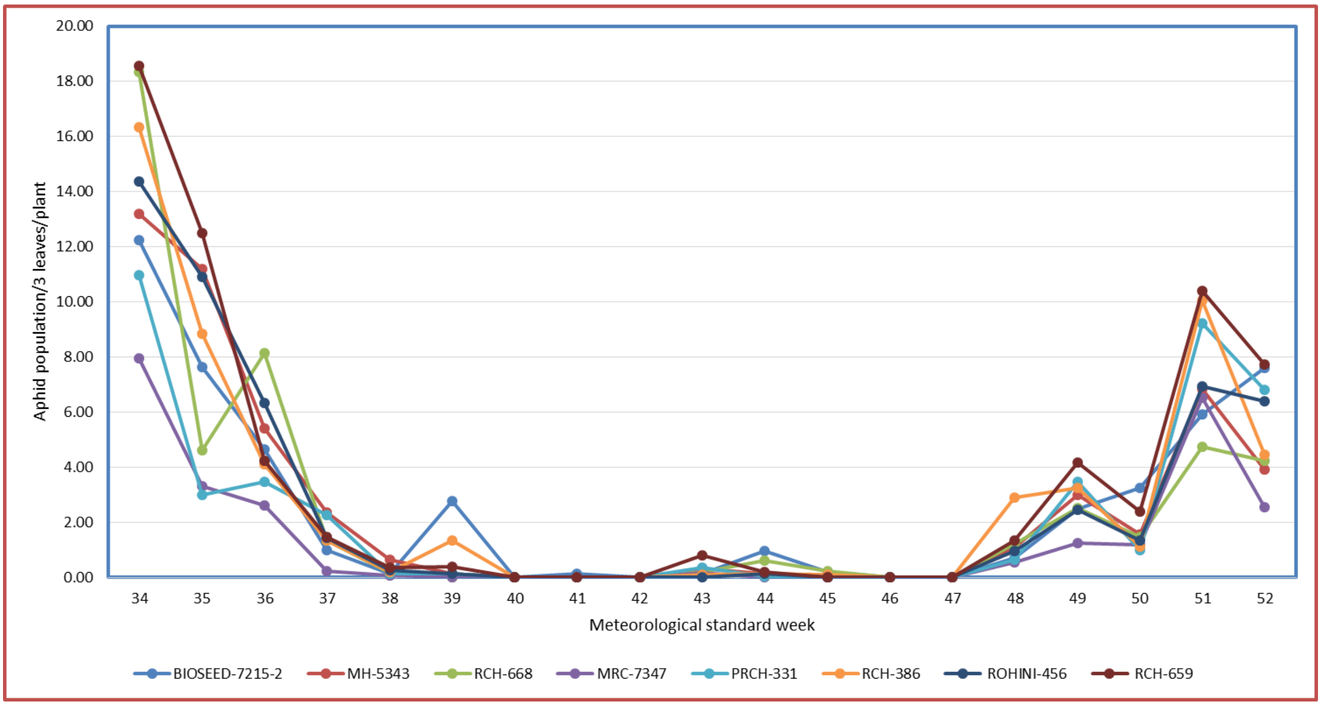

Fig 1: Population dynamics of aphid, *Aphis gossypii* (Glover)in different *Bt* cotton hybrids (pooled)

Table 2: Correlation coefficient (r) of leafhopper with weather parameters in different *Bt*- cotton hybrids

Weather parameters / Hybrids	Temperature (ºC)		Relative humidity (%)		Rainfall (mm)
	Max.	Min.	Morning	Evening	
Bioseed-7215-2	-0.405	0.025	-0.355	-0.030	-0.099
MH-5343	-0.387	0.005	-0.259	0.118	0.071
RCH-668	-0.224	0.068	-0.440	0.048	-0.116
MRC-7347	-0.377	-0.103	-0.288	-0.045	-0.141
PRCH-331	-0.392	-0.022	-0.345	-0.041	-0.124
RCH-386	-0.375	-0.025	-0.272	-0.023	-0.066
ROHINI-456	-0.413	0.028	-0.336	0.108	0.006
RCH-659 (check)	-0.412	0.009	-0.269	0.029	-0.037

Table 3: Multiple linear regression analysis between weather parameters and incidence of leafhopper on different *Bt*-cotton hybrids

Name of the hybrid	Regression equation	R^2
Bioseed-7215-2	$Y=43.10 - 0.86X_1 - 0.05X_2 - 0.19X_3 + 0.07X_4 - 0.07X_5$	0.28
MH-5343	$Y=44.77 -0.92X_1 - 0.03X_2 - 0.20X_3 + 0.07X_4 + 0.02X_5$	0.25
RCH-668	$Y=53.40- 0.43X_1 - 0.22 X_2 - 0.41X_3 + 0.08X_4 - 0.05X_5$	0.29
MRC-7347	$Y=29.49 - 0.50X_1 - 0.24X_2 - 0.11X_3 + 0.03X_4 - 0.07X_5$	0.27
PRCH-331	$Y=40.01- 0.75X_1 - 0.11X_2 - 0.17X_3 + 0.04X_4 - 0.06X_5$	0.24
RCH-386	$Y=48.04-1.01X_1 - 0.13X_2 - 0.18X_3 + 0.07X_4 - 0.08X_5$	0.21
ROHINI-456	$Y=53.71-1.05X_1 - 0.04X_2 - 0.26X_3 + 0.09X_4 - 0.01X_5$	0.31
RCH-659 (check)	$Y=58.02 - 1.35X_1 - 0.01 X_2 - 0.20X_3 + 0.08X_4 - 0.06X_5$	0.23

Where X1 = Maximum temperature
X2 = Minimum temperature
X3 = Morning relative humidity
X4 = Evening relative humidity
X5 = Rainfall

4. Conclusion

The present study concluded that weather factors determine the seasonal activity and population buildup of insect pests in *Bt* cotton crops. The correlation studies clearly show the importance of weather parameters in predicting the sucking pest incidence and these studies will be helpful to farmers and extension workers for developing efficient pest management strategies to get increased cotton production.

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