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Population dynamics of sucking insect pest complex on intra-specific and inter-specific Bt cotton under rainfed situation

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Abstract
The present investigation was conducted to study the population dynamics of sucking insect pest complex on intra-specific and inter-specific Bt cotton hybrids at college of Agriculture, Vijayapur. The results revealed that the maximum population of thrips was noticed during the 36th standard meteorological week (107.60 and 121.43 thrips/3 leaves) and aphids load was highest during 44th SMW (94.20 and 102.17 aphids/3 leaves). Whereas, maximum population of jassids (5.20 and 9.33 jassids/3 leaves) and whiteflies (4.27 and 5.13/3 leaves) were recorded at 41st SMW. Mirid bugs were peaked (3.28 and 3.32 bugs/5 squares) during 44th SMW on ACH-155 BG II (Intra-specific) and MRC-7918 BG II (Inter-specific) Bt cotton hybrids, respectively. Correlation with weather parameters like maximum and minimum temperature was positively correlated with thrips, aphids, jassids and whiteflies. Whereas, rainfall had negative correlation. Mirid bugs were positively correlated with maximum temperature and negatively correlated with minimum temperature, relative humidity and rainfall.

Keywords: Bt cotton, thrips, aphids, jassids, whiteflies, mirid bugs and weather parameters

1. Introduction
Cotton (*Gossypium* spp.) is an important commercial fiber crop of India. It is popularly known as "White Gold" and "King of fiber". In India it is being cultivated in an area of 11.8 million ha with a production of 27.8 million bales and an average productivity of 513 kg/ha. In Karnataka it is grown in 6.12 lakh ha with production of 20 lakh bales and productivity of 556 kg/ha [1]. About 1326 species of insect pests are known to attack the cotton crop across the world at different growth stages of the crop [2]. In recent days sucking pests are causing severe menace in cotton ecosystem. Insect pest complex which are economically important and prejudicial to the Bt cotton are thrips, *Thrips tabaci* (Lindeman); Aphids, *Aphis gossypii* (Glover); Whiteflies, *Bemisia tabaci* (Gennadius); Jassids, *Amrasca biguttula biguttula* (Ishida); Mealy bugs, *Phenococcus solenopsis* (Tinsley); Mirid bugs, *Creontiodes biseratense* (Distant); Shoot weevil, *Alcidodes affaber* (Aurivillius). The incidence and development of all the insect pests are much dependent upon the prevailing environmental factors such as temperature, relative humidity and rainfall [3]. In northern dry zone of Karnataka the cultivation of Bt cotton is not recommended but still 9881 ha area of Vijayapur is under Bt cotton with the production of 21911 tonnes and productivity of 397 kg/ha [4]. Thus, keeping these points in mind, the investigation was undertaken to study the influence of weather parameters on population build up of sucking insect pests on Bt cotton.

2. Material and Methods
A field experiment was carried out at College of Agriculture, Vijayapur, under rainfed situation during *kharif* season 2016-17. The intra-specific Bt cotton hybrid ACH-155-BG II and inter-specific Bt cotton hybrid MRC-7918 BG II were used for the investigation. The crop was raised as per the package of practices [5], under unsprayed condition with a plot size of 8.1 x 5.4 m^2 each with spacing of 90 x 60cm. The observations were recorded from 30 days after sowing to harvest on sucking pests like thrips, aphids, jassids and whiteflies as number of nymphs and adults per top, middle and bottom 3 leaves on randomly selected 5 plants from each treatment, later the population was averaged as number per 3 leaves whereas, mirid bugs were recorded as number of bugs per 5 squares on randomly selected 5 plants.

2.1 Statistical analysis
The data of all insect pests population were subjected to correlation with different weather parameters and analyzed statistically as per the procedure given in Gomez and Gomez [6] to study the influence of weather parameters on fluctuations of sucking pests population on Bt cotton genotypes.

3. Results and Discussion
3.1 Thrips: The population of thrips was observed throughout the crop season on both ACH-155 BG II and MRC -7918 BG II Bt cotton hybrids. The peak incidence of 107.60 and 121.43 thrips / three leaves was recorded on ACH-155 BG II and MRC-7918 BG II, respectively at 36th standard meteorological week (SMW). Minimum population of 1.14 thrips / three leaves on ACH-155 BG II and 2.13 thrips / three leaves on MRC -7918 BG II was noticed at the end of the crop season during 2nd SMW (Fig.1). The results of correlation coefficient revealed that thrips population had a significant positive correlation with maximum temperature (r = 0.530 and r = 0.523) and minimum temperature (r = 0.489 and r = 0.483) and non significant positive correlation with morning relative humidity (r =0.301 and r = 0.304) and evening relative humidity (r = 0.226 and r = 0.222), whereas rainfall showed non-significant negative correlation with thrips population (r = -0.063 and r = - 0.078) on ACH-155 BG II and MRC-7918 BG II Bt cotton hybrids, respectively (Table 1). Similar results were observed by Soujanya *et al.* [7] reported peak incidence of thrips on 35th to 37th standard week and positive correlation with maximum temperature, minimum temperature, and evening relative humidity. Gupta *et al.* [8] noticed peak population of thrips during the second fortnight of August to first fortnight of October with temperature of 30 °C and 74-85 per cent relative humidity. In the present study, among the two hybrids evaluated, inter specific Bt hybrid MRC -7918 BG II recorded highest mean incidence of thrips (46.17 / 3 leaves). Leaf hairyness and trichomes cause irritation while feeding and oviposition of thrips hence their population was less in ACH-155 BG II hybrid as it hold high trichome density and hairyness. Present findings are in line with the findings of Phulse and Udikeri [9] reported that the highest mean incidence of thrips was in inter-specific Bt cotton MRC-7918 BG II (17.30 thrips / 3 leaves). However, slight variation may be due to change in the location, selection of cotton variety, cropping season and changing weather factors.

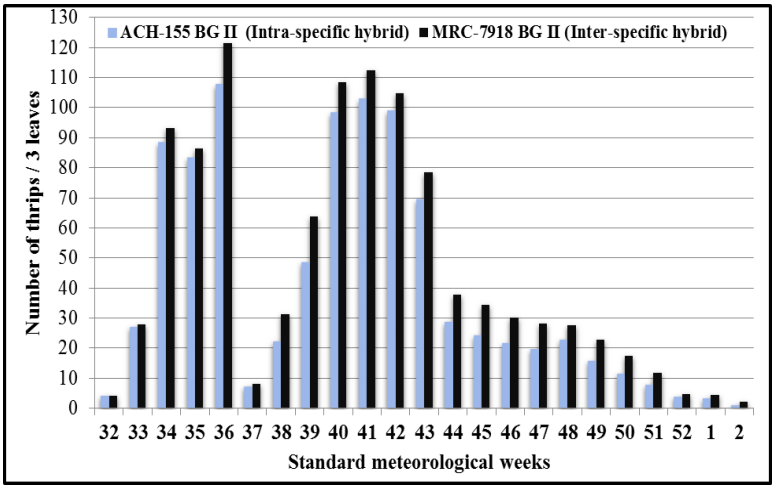

Fig. 1: Population dynamics of thrips, *Thrips tabaci* on intra-specific and inter-specific Bt cotton hybrids

Table 1: Correlation with weather parameters

Maximum temperature (°C)	0.530**	0.523*
Minimum temperature (°C)	0.489*	0.483*
Morning relative humidity (%)	0.301 NS	0.304 NS
Evening relative humidity (%)	0.226 NS	0.222 NS
Rainfall (mm)	-0.063 NS	-0.078 NS

3.2 Aphids: Maximum population of aphids was recorded during 44th SMW of about 94.20 aphids / 3 leaves on ACH-155 BG II and 102.17 aphids / 3 leaves on MRC -7918 BG II. Average aphid population was 24.18 and 27.47 aphids / 3 leaves on ACH-155 BG II and MRC -7918 BG II, respectively (Fig. 2). Aphids had a significant positive correlation with maximum temperature (r = 0.428 & r =0.427) and non significant positive correlation with minimum temperature (r = 0.066 & r = 0.055). However, non significant negative correlation with morning relative humidity (r = -0.146 & -0.146), evening relative humidity (r = -0.096 & r = -0.104) and rainfall (r = -0.225 & r = -0.224) on ACH-155 BG II and MRC-7918 BG II, respectively (Table 2). Present findings are in conformity with the results of Babu and Meghwal [10] who observed highest incidence of aphids during the standard meteorological weeks of 45th to 48th onwards. Bhute *et al.* [11] reported rainfall, rainy days, morning relative humidity and evening relative humidity showed negative correlation with aphids. Phulse and Udikeri [9] who reported that mean population of aphids was more in desi cotton hybrid followed by inter-specific hybrids and intra-specific hybrids.

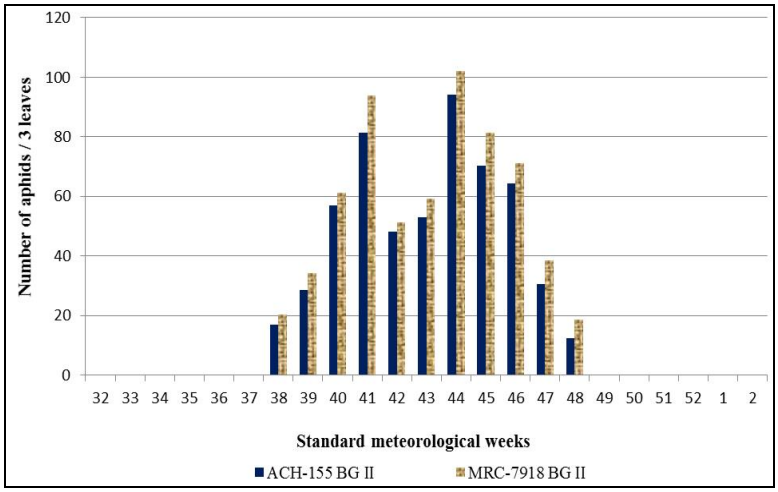

Fig 2: Population dynamics of aphids, *Aphis gossypii* on intra-specific and inter-specific Bt cotton hybrids

Table 2: Correlation with weather parameters

Maximum temperature (°C)	0.428*	0.427*
Minimum temperature (°C)	0.066 NS	0.055 NS
Morning relative humidity (%)	-0.146 NS	-0.146 NS
Evening relative humidity (%)	-0.096 NS	-0.104 NS
Rainfall (mm)	-0.225 NS	-0.224 NS

3.3 Jassids: The jassids population reached its peak during the middle of the crop season. The highest incidence of 5.20 and 9.33 jassids / 3 leaves was obtained from ACH-155 BG II and MRC -7918 BG II, respectively during 41st SMW (Table 3). The average population of jassids documented from both the hybrids during the investigation was 1.26 jassids / 3 leaves on ACH-155 BG II and 3.28 jassids / 3 leaves on MRC -7918 BG II. The correlation coefficient studies revealed that, jassids had a significant positive response with maximum temperature (r = 0.602 & r = 0.597), non significant and positively associated with minimum temperature (r = 0.269 & r = 0.264) and evening relative humidity (r = 0.006 & r = 0.002). Whereas, morning relative humidity (r = -0.038 & r = -0.001) and rainfall (r = -0.111 & r = -0.115) were non-significant and negatively correlated with jassid population on ACH-155 BG II & MRC-7918 BG II, respectively. Similar results were observed by Solangi *et al.* [12] they opined that the mean maximum population of jassids (3.93 jassids / plant) was found in the last week of August at relative mean temperature of 32.88 ºC and Shivanna *et al.* [13] revealed that the maximum temperature correlated significantly and positively with the jassid population and the rainfall correlated negatively. Whereas, minimum temperature and relative humidity showed non-significant effect. Present study revealed that the mean jassid population was highest in inter specific Bt cotton hybrid MRC-7918 BG II (3.28 jassids / 3 leaves) than intra specific hybrid ACH-155 BG II (1.26 jassids / 3 leaves). This may be due to the morphological traits like leaf hairyness, trichome densities are more in *G. herbaceum* species and these traits are not preferred by the jassids as they cause annoyance while feeding and oviposition. The present findings are in agreement with the findings of Phulse and Udikeri [9] who reported that the mean incidence of jassids was highest in inter specific Bt cotton MRC-7918 BG II (5.70 jassids / 3 leaves) followed by MRC 6918 BG-II (5.50 jassids / 3 leaves).

3.4 Whitefly: The maximum number of whiteflies were observed during 41st SMW with population of 4.27 whiteflies / 3 leaves on ACH-155 BG II and 5.13 whiteflies / 3 leaves on MRC -7918 BG II. During the study period the mean incidence of whiteflies was 1.09 / 3 leaves and 1.54 / 3 leaves on ACH-155 BG II and MRC-7918 BG II, respectively (Table 4). Correlation studies depicted that whiteflies had a positive and non-significant correlation with maximum temperature (r = 0.402 and r = 0.386), minimum temperature (r = 0.274 and r = 0.219), morning relative humidity (r = 0.028 and r = 0.035) and evening relative humidity (r = 0.093 and r = 0.055). However, rainfall exhibited negative correlation (r = -0.132 and r = -0.183) with whiteflies but were found to be non-significant on both ACH-155 BG II and MRC-7918 BG II, respectively. Present findings are in close agreement with Prasad *et al.* [14] they revealed that the maximum and minimum temperature range of 29 ºC – 32 ºC and 18 ºC – 22 ºC, respectively were highly favorable for the population build up of whiteflies. Umar *et al.* [15] reported that whitefly population was positively correlated with temperature and relative humidity. Hegde *et al.* [16] noticed the peak population of whitefly in October with 6.43 / 3 leaves. Phulse and Udikeri [9] reported that the mean number of whiteflies was more in inter-specific Bt cotton MRC-7918 BG II (0.31 / 3 leaves) followed by MRC 6918 BG-II (0.25 / 3 leaves), RCH-2 BG-II (intra-specific) (0.22 / 3 leaves).

3.5 Mirid bugs: The peak infestation of mirid bugs were recorded on ACH-155 BG II & MRC-7918 BG II during 44th SMW (3.28 & 3.32 mirid bugs / 5 squares, respectively). The average incidence during the cropping season was 0.93 and 0.96 / 5 squares on ACH-155 BG II and MRC -7918 BG II hybrids, respectively (Table 5). The peak incidence was noticed in November may be due to the availability of more number of flowers and squares. The outcome of simple correlation with weather parameters indicated positive and non significant relationship with maximum temperature (r = 0.280 and r = 0.313) and negative correlation with minimum temperature (r = -0.198 and r = -0.232), morning relative humidity (r = - 0.330 and r = -0.350), evening relative humidity (r = -0.295 and r = -0.333) and rainfall (r = -0.312 and r = -0.352) on both ACH-155 BG II and MRC -7918 BG II hybrids, respectively**.** The present findings are in line with the findings of Khan *et al.* [17] Patil *et al.* [18] who found that the November-January months were most favorable for the development of mirid bugs. Rohini *et al.* [19] recorded the peak incidence of mirid bug during October and November and their incidence was low to moderate in Gulburga (2.19), Davangere (2.90), Bijapur (3.03) and Belgaum (5.02 bugs / 5 squares).

Table 3: Population dynamics of jassids, *Amrasca biguttula biguttula* (Ishida) on intra-specific and inter-specific Bt cotton hybrids

Months	Standard meteorological weeks	Mean number of jassids / 3 leaves	
		ACH-155 BG II (Intra-specific hybrid)	MRC-7918 BG II (Inter-specific hybrid)
August	32	0.00	0.00
	33	0.67	1.13
	34	0.80	3.86
September	35	1.47	4.13
	36	2.17	4.73
	37	0.13	1.80
	38	0.80	1.60
October	39	1.86	2.00
	40	1.13	7.17
	41	5.20	9.33
	42	4.33	7.67
	43	4.13	7.40
November	44	2.00	6.17
	45	1.33	4.67
	46	1.00	4.33
	47	0.73	4.00
December	48	0.40	3.67
	49	0.67	1.00
	50	0.20	0.87
	51	0.00	0.00
	52	0.00	0.00
January	1	0.00	0.00
	2	0.00	0.00
Mean incidence		1.26	3.28
Correlation with weather parameters			
Maximum temperature (°C)		0.602**	0.597**
Minimum temperature (°C)		0.269 NS	0.264 NS
Morning relative humidity (%)		-0.038 NS	-0.001 NS
Evening relative humidity (%)		0.006 NS	0.002 NS
Rainfall (mm)		-0.111 NS	-0.115 NS

Table 'r' value at (n-2 df) 5% is 0.413 and at 1% is 0.526. * Significant at P=0.05, ** Significant at P=0.01, NS = non significant.

Table 4: Population dynamics of whitefly, *Bemisia tabaci* (Gennadius) on intra-specific and inter-specific Bt cotton hybrids

Months	Standard meteorological weeks	Mean number of whiteflies / 3 leaves	
		ACH-155 BG II (Intra-specific hybrid)	MRC-7918 BG II (Inter-specific hybrid)
August	32	0.00	0.00
	33	0.00	0.00
	34	0.48	0.87
September	35	0.33	0.60
	36	0.40	0.67
	37	0.20	0.27
	38	0.87	1.00
October	39	2.60	3.13
	40	3.40	4.87
	41	4.27	5.13
	42	3.17	3.27
	43	2.87	3.13
November	44	2.61	3.00
	45	1.13	2.80
	46	1.00	2.63
	47	0.87	1.47
December	48	0.67	1.13
	49	0.20	0.67
	50	0.08	0.48
	51	0.00	0.27
	52	0.00	0.00
January	1	0.00	0.00
	2	0.00	0.33
Mean incidence		1.09	1.54
Correlation with weather parameters			
Maximum temperature (°C)		0.402 NS	0.386 NS
Minimum temperature (°C)		0.274 NS	0.215 NS
Morning relative humidity (%)		0.028 NS	0.035 NS
Evening relative humidity (%)		0.093 NS	0.055 NS
Rainfall (mm)		-0.132 NS	-0.183 NS

Table 'r' value at (n-2 df) 5% is 0.413 and at 1% is 0.526. * Significant at P=0.05, ** Significant at P=0.01, NS = non significant.

Table 5: Population dynamics of mirid bugs *Campylomma livida* (Reuter) on intra-specific and inter-specific Bt cotton hybrids

Months	Standard meteorological weeks	Mean number of mirid bugs / 5 squares	
		ACH-155 BG II (Intra-specific hybrid)	MRC-7918 BG II (Inter-specific hybrid)
August	32	0.00	0.00
	33	0.00	0.00
	34	0.00	0.00
September	35	0.00	0.00
	36	0.00	0.00
	37	0.20	0.00
	38	0.52	0.56
October	39	0.76	0.68
	40	0.92	0.96
	41	1.04	1.08
	42	1.18	1.24
	43	1.88	1.94
November	44	3.28	3.32
	45	2.00	2.16
	46	3.16	3.26
	47	1.18	1.26
December	48	1.00	1.34
	49	2.20	2.34
	50	1.00	1.00
	51	0.80	0.60
	52	0.22	0.34
January	1	0.00	0.00
	2	0.00	0.00
Mean incidence		0.93	0.96
Correlation with weather parameters			
Maximum temperature (°C)		0.280 ^{NS}	0.313 ^{NS}
Minimum temperatures (°C)		-0.198 ^{NS}	-0.232 ^{NS}
Morning relative humidity (%)		-0.330 ^{NS}	-0.350 ^{NS}
Evening relative humidity (%)		-0.295 ^{NS}	-0.333 ^{NS}
Rainfall (mm)		-0.312 ^{NS}	-0.352 ^{NS}

Table 'r' value at (n-2 df) 5% is 0.413 and at 1% is 0.526. * Significant at P=0.05, ** Significant at P=0.01, NS = non significant.

4. Conclusion

In the light of results and numerical data, it is concluded that the intra-specific Bt cotton hybrid ACH-155 BG II had a minimum pest density and it performed well under northern dry land condition. However, the sucking pests like thrips, aphids, jassids, whiteflies and mirid bugs were found highest in inter-specific Bt cotton hybrid MRC-7918 BG II than intra-specific Bt cotton hybrid ACH-155 BG II. Maximum population of thrips was observed in the month of September. Whereas, jassids and whiteflies peaked in October. While aphids and mirid bugs were maximum in the month of November. Maximum and minimum temperature was positively correlated with thrips, aphids, jassids and whiteflies. However, rainfall had a negative correlation. Mirid bugs were negatively correlated with minimum temperature, relative humidity and rainfall but maximum temperature had a positive relationship with mirid bugs population.

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