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Population dynamics of aphid (*Aphis gossypii*) and jassid (*Amrasca biguttula biguttula*) in Bt cotton.

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Abstract
An Experiment was conducted at District seed farm, Bidhan Chandra Krishi Viswavidyalay, Kalyani, Nadia to understand the population fluctuation of two major sucking pest in Bt cotton i.e. cotton aphid and cotton jassid along with correlation with weather factors for consecutive two years during *Rabi* season 2016-17 and 2017-18. According to two years mean data, aphid population first appeared in the field during 3rd standard metrological week (SMW) and after the population progressively increased and reached its peak (139.00 aphids per leaf) in 9th meteorological week whereas Jassid *Amrasca biguttula biguttula* infestation was first noticed in the field at early vegetative stage of crop i.e. 3rd meteorological week and remained more or less active throughout the growing season of cotton and reached its peak population (53.10 per 10 leaves) in 8th meteorological week after that the population showed fluctuating downward and reached the lowest level (8.06/10 leaves) at 20th standard meteorological week.

Keywords: Cotton, aphid, jassid, population dynamics

1. Introduction
Cotton (*Gossypium hirsutum* L.), is the "King of Fiber" popularly known as "White Gold", an important cash crop in India and being the principal material for flourishing textile industries. Cotton comes under Family Malvaceae, and Tribe Gossypieae (Smith 1995) [1]. India occupies first place in area and second in production on global basis after China. Cotton contributes to 29.8 per cent of India's agricultural gross domestic production. The area under Bt cotton in India reached 7.6 million ha. in 2008-2009 (Karihaloo and Kumar,2009) [2]. Among the various causes of low productivity of cotton in India, the insect pests is one of the major and burning concern. About 200 insect pests are reported to attack cotton crop in India (Anonymous, 1992) [3]. Amongst several factors responsible for low productivity, the sucking pests, aphid (*Aphis gossypii*, Glover), leaf hopper (*Amrasca biguttula biguttula*, Ishida) are of regular occurrence on non-Bt as well as in Bt cotton. The yield losses of cotton due to sucking pests attack up to 8.37% were reported by Banerjee (2002) [4]. The heavy infestation by nymph and adults of sucking pests resulted in leaf yellowing, wrinkled leaves, leaf distortion and oily spots on leaves. The leafhopper, *Amrasca biguttula biguttula* (Ishida) (Homoptera: Cicadellidae) is an alarming pest. It has a broad host range including cotton, okra, brinjal and jute. Both nymph and adult stages can destroy the plants by sucking the sap from leaves and also transmitting different viruses. As a matter of heavy doses of insecticides usage against it the leafhopper has revealed resistance against endosulfan, monochrotophas, phosphamidon and cypermethrin (Chalam and Subbaratanam, 1999) [5]. A moderate to high level of resistance against the neonicotinoids *viz.*, imidacloprid and acetamiprid (Kshirsagar *et al.*, 2012) [6] has also been evidenced in leafhopper. Another important sucking pest is the cotton aphid (*Aphis gossypii*) whose population is increasing in last ten years. The high aphid populations may stunt and retard cotton seedling growth and development as a result of its feeding. Late season populations can cause decreased fiber quality as a result of stickiness and the development of sooty mould associated with honeydew dropped onto cotton fibers (Isely, 1946) [7]. The control failures might have been aggravated due to the development of resistance in aphid also. Bt cottons has been experienced that reduction in usage of insecticides lead to increased population of sucking insect pests (Men *et al.*, 2005) [8]. Sucking pests are found infesting from seedling stage and continue till maturity of the crop which causes considerable losses in yield. Patil (1998) [9] reported an average 12% yield loss due to attack of aphids and jassids in early stage of cotton crop in India. The present information on aphids and Jassids of Bt cotton in new alluvial zone of West Bengal is not enough. Information regarding these sucking pests in

Bt cotton need to be updated for adopting effective management strategies. Therefore, keeping the above information in view, the present investigation was undertaken.

2. Materials and Methods

In order to study the population dynamics and impact of weather parameters on incidence of *Aphis gossypii* and *Amrasca biguttula biguttula* in Bt cotton, a field experiment was carried out at District seed farm Bidhan Chandra Krishi Viswavidyalaya for consecutive two year during *Rabi* season 2016-17 and 2017-18 on variety "Suraj". Cotton seed (cv-Suraj) was sown on middle of November for both seasons maintaining row to row and plant to plant distance of 90cm and 75 cm respectively and standard agronomic practices were carried out as usual.

The observations on *Aphis gossypii* and *Amrasca biguttula biguttula* were recorded at weekly interval. Observations on the number of nymph and adults of aphids and jassids was recorded from two leaves per plant selected from top, middle and bottom canopy from the selected plants at weekly interval starting from 15 days after germination till the removal of the crop. Plots were kept completely free from the insecticidal spray. For this purpose, 15 plants were randomly selected and tagged. Observation on aphid and jassid population was recorded from randomly selected plants. Data regarding weather parameters were obtain from All India Co-ordinated Research Project on Agricultural Meteorology, Directorate of Research, Bidhan Chandra Krishi Viswavidyalaya, Kalyani, West Bengal. The relationship between weather factors and sucking pests was established by using simple correlation coefficient and regression analysis.

3. Results and Discussions

3.1 Population fluctuation of Aphid, *Aphis gossypii* (Glover) in Bt cotton during *Rabi* season, 2016-17.

The seasonal fluctuation of aphid population, *Aphis gossypii* was monitored in Bt cotton under field condition during 2016-17 and 2017-18. In fact aphid population dynamic are strongly influenced by climatic conditions and cool spring and fall of temperature as reported by (Hajek and Dahisten, 1988) [10]. The abundance of this pest population is dramatically affected by changes of weather factors. However, aphid population first appeared in the field during 3rd standard metrological week (SMW) (Fig 1). After that the population progressively increased and reached its peak (139.00 aphids per leaf) in the 9th meteorological week (Fig 1). When the population first appeared in the field the crop was in early vegetative stage and this pest was highly active during winter period due to favourable environmental condition. Later on, the infestation of aphid population gradually declined and became nil in the 15th standard metrological week (SMW) when the atmospheric temperature was quite high. The present finding is in accordance with findings of (Ruchika and Dolly, 2015) [11] who reported that 3rd week of February population was increased gradually and peach population was observed in1st week of March i.e. 9th meteorological week. Correlation between various abiotic factors viz., maximum temperature (r = 0.85), minimum temperature (r= 0.76), total rainfall (r= 0.53) was found positive whereas maximum relative humidity (r= - 0.31) minimum relative humidity (r= - 0.20) and sunshine hour (r=0.49) were negatively correlated with aphid population (Table 4). The present findings are in agree with the finding of (Mohapatra, 2008) [12] who found that significant increased incidence of aphid population in all genotype of cotton from 3rd week of January to end of February. It could be due to positive correlation of aphid with maximum temperature and minimum temperature. Similarly, (Kumara *et al*., 2017) [13] reported that aphids on cotton had significant positive correlation with maximum temperature, minimum temperature(r=0.31), (r = 0.15) respectively. Whereas, non-significant negative correlation was observed with maximum humidity and minimum humidity and bright sunshine hours (r = -0.19) (r = -0.22) (r= 0.40) respectively (Table 1).

3.2 Population fluctuation of Aphid, *Aphis gossypii* (Glover) in Bt cotton during *Rabi* season, 2017-18.

The result of the same trend observed in second experiment during the year 2017-18. The Aphid population (*Aphis gossypii*) is mainly influenced by the variation of abiotic factors *viz*., maximum temperature, minimum temperature, maximum relative humidity, minimum relative humidity, bright sunshine hours and total rainfall. During the period of investigation, aphid population showed fluctuation in numbers; they were recorded between 5.0 to 133.60 per leaf (Fig 2). However, the initial population was recorded during the 3rd standard meteorological week (11.0 aphids per leaf). This population gradually increased and attained at peak densities in 9th standard meteorological week (133.60 aphids per leaf) when the air temperature and total rainfall remained fairly low (Fig 5). This study demonstrated the fact that aphid population exhibited significant positive correlation with the minimum temperature (r= 0.87) and negative correlation with maximum temperature (r=- 0.52), maximum relative humidity (r=- 0.38), minimum relative humidity (r=- 0.70) and bright sunshine hours (r= - 0.15) (Table 2).

3.3 Population fluctuation of Jassid, *Amrasca biguttula biguttula* (Ishida) in Bt cotton during *Rabi* season, 2016-17.

The seasonal incidence of cotton jassid, *Amrasca biguttula biguttula* (Ishida) in Bt cotton was monitored under field condition during 2016-17. The population of Jassid, *A. biguttula biguttula* was first noticed in the field at early vegetative stage of crop i.e. 3rd meteorological week and remained more or less active throughout the growing season of cotton. The population was ranged between 4.03-26.55 per 10 leaves but its peak population 53.10 per 10 leaves was recorded in 8th meteorological week after that the population showed fluctuating downward and reached the lowest level 8.06/10eaves at 20th SMW (Fig 3). Correlation of jassid population (Table 3) with weather parameters revealed that maximum temperature (r=0.81), minimum temperature (r= 0.83) and minimum relative humidity (r=0.51) showed significant positive influence on population growth of jassid during crop seasons. Moreover, significantly negative correlation was observed in case of maximum relative humidity (r = - 0.30), total rainfall r = - 0.64) and bright sunshine hours (r = - 0.4). Present findings are in close conformity with the observation of Rajesh and Dhakad (2016) [14] reported that among different abiotic factors, maximum temperature and minimum temperature had significant positive correlation whereas maximum relative humidity and rainfall significant negative correlation with jassid population.

3.3 Population fluctuation of Jassid, *Amrasca biguttula biguttula* (Ishida) in Bt cotton during *Rabi* season, 2017-18.

The similar trend of results was observed in second year

experiment 2017-18. During the period of investigation, jassid population showed fluctuation in numbers and they were recorded between 5.33 to 48.33 per 10 leaves (Fig 4). However, the initial population jassid was recorded during the 3rd standard meteorological week (16.0 jassids per 10 leaves) and maintained relatively good number of population throughout the growing season of this crop. Therefore, this population gradually increased and attained its peak densities in 8th standard meteorological week (48.33 jassids per 10 leaves) when the atmospheric temperature and relative humidity remained fairly high (Fig 4). Later on, the population was showed fluctuating and reached the least level of population (5.32 jassids per 10 leaves) when the crop attained near senescence stage i.e 19th standard meteorological week. This study established the fact that jassid population exhibited significant positive correlation with the maximum temperature (r= 0.67), minimum temperature (r= 0.86) and negative correlation with relative humidity (r= - 0.22), total rainfall (r= - 0.64) and bright sunshine hours (r= - 0.23) (Table 4). The similar finding reported by (Bhute *et al*., 2012) [15] reported that maximum temperature was positively correlated and relative humidity was negatively correlated with jassid population. The present finding are also in agree with the scientist of (Ashfaq *et al*., 2011 [16]; Simwat & Gill, 1992 [17]; Gogoi and Dutta, 2000 [18]) who reported that jassid population was positively correlated with air temperature while negatively correlated with relative humidity.

Table 1: Correlation and Regression Coefficient of Aphid, *Aphis gossypii* (Glover) in Bt cotton with weather factors during 2016-17.

Weather parameters	Correlation(r)	Regression Equation
Max. Temperature (^{0}C)	0.76	$y = -4.0791x^2 + 253.66x - 3845.6$ $R^2 = 0.5788$
Min. Temperature (^{0}C)	0.85	$y = -1.348x^2 + 47.498x - 314.01$ $R^2 = 0.7279$
Max. Relative Humidity (%)	-0.31	$y = 1.9358x^2 - 348.1x + 15700$ $R^2 = 0.0989$
Min. Relative humidity	-0.20	$y = 0.007x^2 - 2.0136x + 140.98$ $R^2 = 0.0443$
Total Rainfall (mm)	0.53	$y = -546.67x^2 + 386.3x + 63.226$ $R^2 = 0.282$
Bright sunshine hour (hrs)	-0.49	$y = 11.673x^2 - 166.32x + 627.65$ $R^2 = 0.2489$

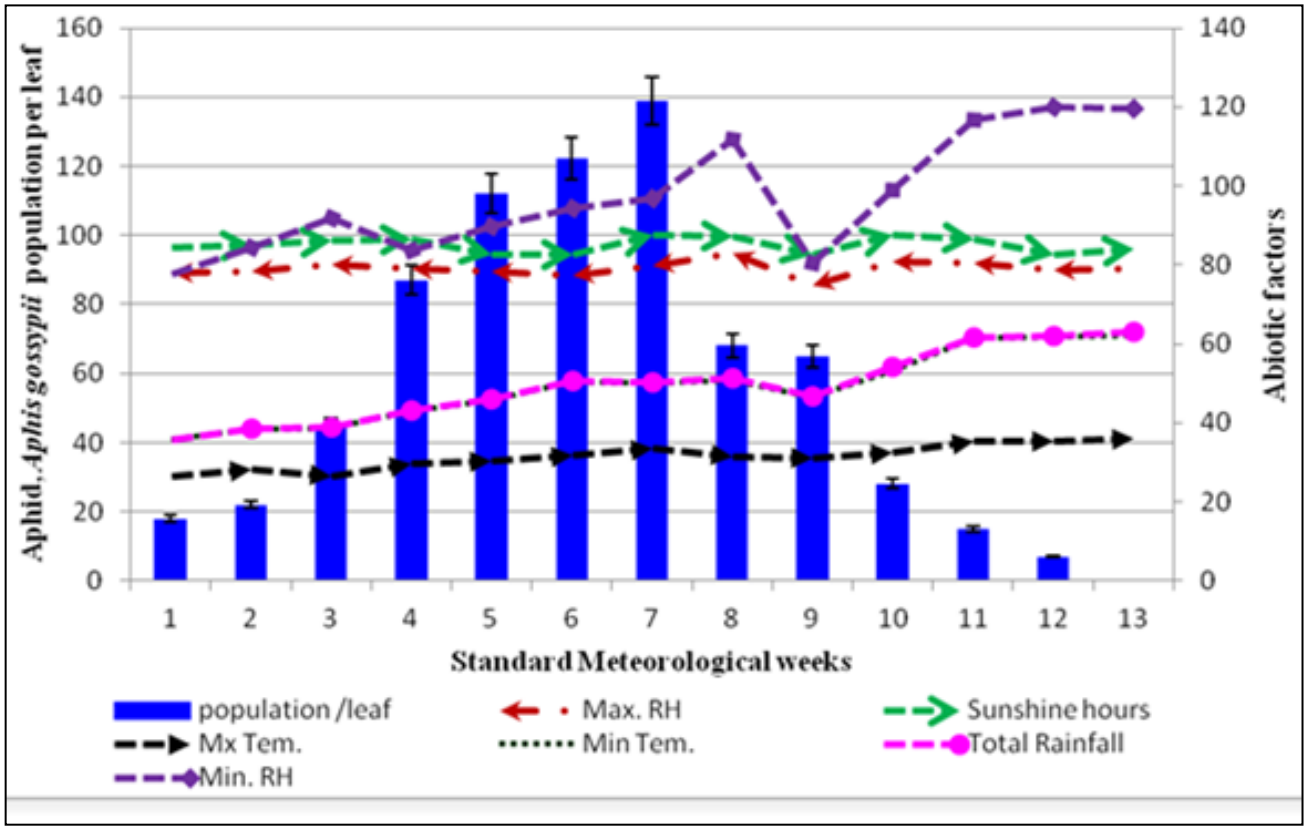

Fig 1: Population fluctuation of Aphid, *Aphis gossypii* (Glover) infesting Bt cotton (cv. Suraj) during *Rabi* season 2016- 17.

Table 2: Correlation and Regression Coefficient of Aphid, *Aphis gossypii* (Glover) in Bt cotton with weather factors during *Rabi* season 2017 - 18.

Weather parameters	Correlation(r)	Regression Equation
Max. Temperature (^{0}C)	-0.52	$y = -2.9466x^2 + 181.87x - 710.6$ $R^2 = 0.273$
Min. Temperature (^{0}C)	0.87	$y = -2.3036x^2 + 73.227x - 465.24$ $R^2 = 0.7732$
Max. Relative Humidity (%)	-0.38	$y = 0.891x^2 - 166.6x + 7827.1$ $R^2 = 0.146$
Min. Relative humidity (%)	-0.70	$y = -0.0225x^2 - 2.8507x + 226.4$ $R^2 = 0.496$
Total Rainfall (mm)	-0.52	$y = 15.336x^2 - 91.997x + 66.903$ $R^2 = 0.2693$
Bright sunshine hour (hrs)	-0.15	$y = 3.0892x^2 - 38.294x + 167.08$ $R^2 = 0.0256$

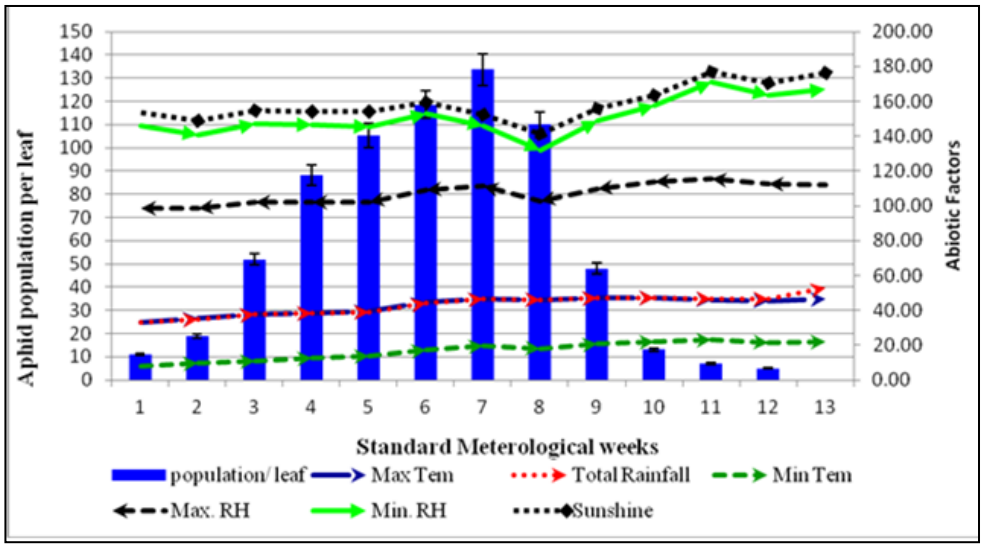

Fig 2: Population fluctuation of *Aphid, Aphis gossypii* (Glover) infesting Bt cotton (cv. Suraj) during *Rabi* season 2017-18.

Table 3: Correlation and Regression Coefficient of Jassid, *Amrasca biguttula biguttula* (Ishida) in Bt cotton with weather factors during *Rabi* season 2016-17.

Weather parameters	Correlation(r)	Regression Coefficient (X)
Max. Temperature (^{0}C)	0.81	$y = -0.912x^2 + 57.218x - 859.14$ $R^2 = 0.6649$
Min.Temperature (^{0}C)	0.83	$y = -0.3821x^2 + 13.356x - 76.275$ $R^2 = 0.7047$
Max. Relative Humidity (%)	-0.30	$y = 0.6021x^2 - 109.43x + 4994.8$ $R^2 = 0.0926$
Min. Relative humidity	0.51	$y = -0.0194x^2 + 1.0373x + 23.51$ $R^2 = 0.2631$
Total Rainfall (mm)	-0.64	$y = 0.695x^2 - 8.2839x + 31.351$ $R^2 = 0.4162$
Bright sunshine hour (hrs)	-0.40	$y = 2.7037x^2 - 39.864x + 167.04$ $R^2 = 0.1681$

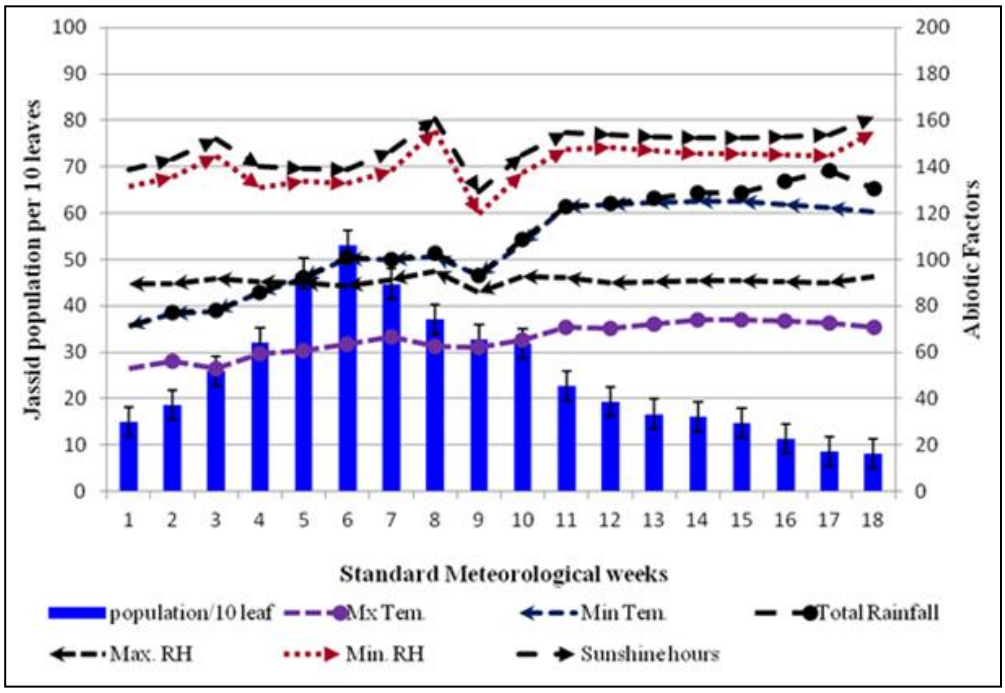

Fig 3: Population fluctuation of Jassid, *Amrasca biguttula* (Ishida) infesting Bt cotton (cv. Suraj) during Rabi season 2016- 17.

Table 4: Correlation and Regression Coefficient of Jassid, *Amrasca biguttula biguttula* (Ishida) in Bt cotton with weather factors during *Rabi* season 2017-2018.

Weather parameters	Correlation(r)	Regression Coefficient (X)
Max. Temperature (^{0}C)	0.67	$y = -0.7677x^2 + 46.651x - 670.23$ $R^2 = 0.4548$
Min. Temperature (^{0}C)	0.86	$y = -0.3621x^2 + 11.415x - 50.918$ $R^2 = 0.7422$
Max. Relative Humidity (%)	- 0.22	$y = -0.6009x^2 + 106.01x - 4646.5$ $R^2 = 0.0521$
Min. Relative humidity (%)	0.70	$y = -0.0273x^2 + 1.605x + 11.44$ $R^2 = 0.4913$
Total Rainfall (mm)	-0.64	$y = 3.6681x^2 - 21.483x + 29.639$ $R^2 = 0.4106$
Bright sunshine hour (hrs)	-0.23	$y = 2.519x^2 - 37.195x + 158.45$ $R^2 = 0.0532$

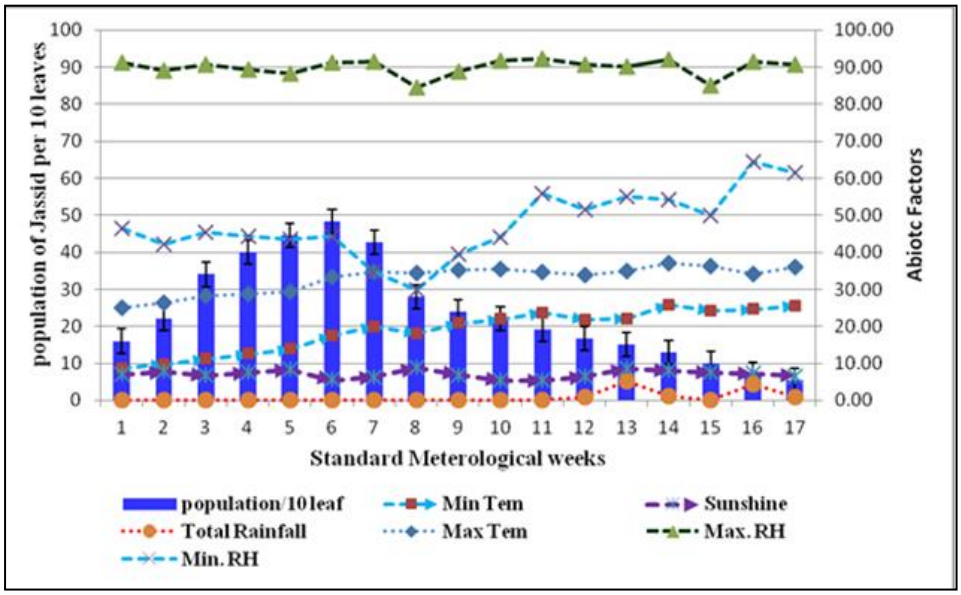

Fig 4: Population fluctuation of Jassid, *Amrasca biguttula biguttula* (Ishida) infesting Bt cotton (cv. Suraj) during *Rabi* season 2017-18.

4. Conclusion

According to two years average data, aphid population first appeared in the field during 3rd standard metrological week (SMW) and after the population progressively increased and reached its peak (139.00 aphids per leaf) in 9th meteorological week whereas jassid (*A. biguttula biguttula*) infestation was first noticed in the field at early vegetative stage of crop i.e. 3rd meteorological week and remained more or less active throughout the growing season of cotton and reached its peak population (53.10 per 10 leaves) in 8th meteorological week after that the population showed fluctuating downward and reached the lowest level (8.06/10 leaves) at 20th standard meteorological week. Among the weather factors maximum temperature showed positive correlation with jassid (*A. biguttula biguttula*) population whereas, minimum temperature exhibited positive correlation with aphid population. The rainfall is favorable for the activity of both the pests.

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