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Population dynamics of whitefly (*Bemisia tabaci*, Genn.) and Thrips (*Scirtothrips dorsalis*, Hood.) 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 whitefly and cotton thrips along with correlation with weather factors for consecutive two years during *Rabi* season 2016-17 and 2017-18. According to two years mean data, whitefly infestation was first recorded in 3rd standard meteorological week (SMW) of the crop and continued up to 15th SMW. However, it reached its peak population in 13th SMW with a population 41.30 per 5 leaves. The thrips population first commenced at 7th standard meteorological week, maximum population (160.0 thrips per leaf) was recorded on 14th SMW and least population (2.30 thrips/leaf) was recorded on 20th SMW. Among the weather factors maximum temperature showed positive correlation whitefly, *Bemisia. tabaci* and thrips, *Scirtothrips dorsalis* population the rainfall is favorable the activity of whitefly whereas the thrips were unaffected by rainfall.

Keywords: Cotton, whitefly, Thrips, population dynamics.

Introduction
Cotton (*Gossypium* spp.) is an important fibre crop of global importance, typically grown in tropical and subtropical regions of the world over. In India, cotton is grown in about 8.70 million hectare with a total production of 148 lakh bales and it occupies 5% of the total cropped area (Anon., 2003) [1]. It is the 3rd largest global cotton producer after USA & China and surprisingly it ranks 1st with respect to area under cultivation throughout the world but unfortunately the productivity is very low with 322 kg/ha as against the world average of 621 kg/ha (Anon., 2004) [2] It plays a vital role in the national economy as it contributes 29.8 per cent of India's agricultural gross domestic production. It is exported both directly and indirectly, directly as lint and indirectly as textile accounting 33 per cent (Anon, 2007) [3]. Of the several factors contributing for low yield of cotton, biotic constraints appear to be very important, of which the ravages caused by insect pest assume greater importance. According to Kannan and Uthamasamy (2004) [4], the low yields (up to 35–40%) are mainly attributable to insect pests. Bt cotton can effectively control specific lepidoptera species, but lack of resistance against sucking insect pests (Hofs *et al.*, 2004 [5]; Sharma and Pampapthy, 2006) [6]. Among insect pests whitefly (*Bemisia tabaci,* Genn.) and thrips (*Thrips tabaci,* Linn.) are of regular occurrence on non-Bt as well as in Bt cotton. The heavy infestation by nymph and adults of sucking pests resulted in leaf yellowing, wrinkled leaves, leaf distortion and oily spots on leaves. Secondly, they found to secrete honey dew which leads to growth and development of sooty mould fungus (*Capnodium sp.*) on leaves. The fungus inhibits the photosynthetic activity of the plants causing chlorosis. Moreover, whitefly also acts as a vector to transmit leaf curl disease in cotton. Bt cottons has been experienced that reduction in usage of insecticides lead to increased population of the above sucking insect pests. In the absence of transgenic genes targeting these sucking pests, the cotton growers heavily depend on synthetic pesticides in India. The present information on sucking pest in Bt cotton in new alluvial zone of West Bengal is not enough. Information regarding 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 whitefly (*Bemisia tabaci*, Genn.) and thrips (*Thrips tabaci*, Linn.) 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 whitefly (*Bemisia tabaci*, Genn.) and thrips (*Thrips tabaci*, Linn.) were recorded at weekly interval. Observations on the number of nymph and adults of whitefly and thrips 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 whitefly, *Bemisia tabaci* (Gennadius) infesting Bt cotton (cv. Suraj) during *Rabi* season 2016- 17.

The seasonal incidence of whitefly, *Bemisia tabaci* (Gennadius) in Bt cotton was monitored under field condition at District Seed Farm BCKV, Kalyani, Nadia during 2016-17 and is presented in (Fig 1). Whitefly population started its appearance in cotton from 3rd meteorological week (SMW) but it attained its pest status onwards 6th SMW and maintained good population till 15th SMW. However, it reached its peak population in 13th SMW with a population 41.30 per 5 leaves. The population gradually declined onwards 15th SMW when the crop reached near senescence stage and this population was found below the economic injury level. Correlation of whitefly population (Table 1) with weather parameters revealed that maximum temperature (r=0.76), minimum temperature (r=0.56) and maximum relative humidity (r=0.42) had positive influence on population growth of whitefly during the period of investigation. Whereas, significantly negative correlation was observed in case of minimum relative humidity (r = - 0.31), total rainfall (r = - 0.63) and bright sunshine hours (r = -0.45). Present findings are in close conformity with the observation of the author (Kataria *et al*., 2017) [7] who have reported that among different abiotic factors, maximum temperature, minimum temperature and maximum had showed positive correlation whereas minimum relative humidity and rainfall significant negative correlation with whitefly population in cotton.

3.2. Population fluctuation of whitefly, *Bemisia tabaci* (Gennadius) infesting Bt cotton (cv. Suraj) during *Rabi* season 2017-18.

The similar trend of result was observed in second year experiment 2017-18. The whitefly, *Bemisia tabaci* population is strongly influenced by the variation of abiotic factors *viz*., maximum temperature, minimum temperature, maximum relative humidity, minimum relative humidity, bright sunshine hours and total rainfall. The abundance of aphid population changes dramatically with weather factors. However, during the period of investigation, whitefly population showed fluctuation in their numbers; they were recorded between 8.80 to 41.70 per 10 leaves (Fig 2). The initial population jassid was recorded during the 3rd standard meteorological week (8.80 whitefly per 10 leaves) and maintained good number of population throughout the growing season. However, this population gradually increased and attained its massive n umber in 13th standard meteorological week (41.70 whitefly per 10 leaves) when the atmospheric temperature remained quite high (Fig 2). Thereafter, this population showed fluctuating and reached the lowest level (6.70 whitefly per 10 leaves) when the crop reached near senescence stage i.e. 19th standard meteorological week. This study showed the fact that whitefly population exhibited significant positive correlation with the maximum temperature (r= 0.52), minimum temperature (r= 0.70) and relative humidity (r= 0.41) and negative correlation was established with total rainfall (r= - 0.70) and bright sunshine hours (r = -0.40) (Table 2). The similar finding was observed by (Kataria *et al*., 2017) [8] who noted that minimum temperature, maximum temperature and minimum relative humidity was positively correlated whereas total rainfall and bright sunshine hours was negatively correlated with whitefly population in cotton. But the result of this study was found opposing to the findings of (Kadam *et al*., 2015; [9] Ashfaq *et al.* 2010 [10] and Akram *et al.*, 2013) [11] (Fig 2).

3.3. Population fluctuation of Thrips, *Scirtothrips dorsalis* (Hood) infesting Bt cotton (cv. Suraj) during *Rabi* season 2016- 17.

The seasonal abundance of Thrips, *Scirtothrips dorsalis* (Hood) in Bt cotton was monitored under field condition at District Seed Farm BCKV, Kalyani, Nadia during 2016-17 and is presented in (Fig 3). The thrips population first commenced at 7th standard meteorological week. The significant difference among this population was observed during the period of investigation and this pest population ranged from 3.0 to 160.0 per leaf. But maximum population (160.0 thrips per leaf) was recorded on 14th SMW and maintained substantial population till 16th SMW. Afterwards this population gradually went to turn down and least population (2.30 thrips per leaf) was recorded on 20th SMW. The trend of thrips infestation in the present studies more or less similar to the author of Pawar *et. al*., (2008) [12] reported that thrips population commenced on last week of February and reached its peak population during middle of March after that population became dwindling. Correlation between various abiotic factors viz., maximum temperature (r= 0.41), maximum relative humidity (r= 0.63) and total rainfall (r= 0.35) was found to be positive whereas minimum temperature (r = - 0.57), minimum relative humidity (r= - 0.26) and bright sunshine hours (r= - 0.32) were negatively correlated with thrips population (Table 3). The present findings are in line with the finding of Janu, *et al.*, (2017) [13], who found that the activity of thrips population in cotton enhanced with the rise of maximum relative humidity. Therefore, the present finding confirmed that dynamics of thrips, *S. dorsalis* infesting cotton cv Suraj with slight variations which could be attributed to climate changes, growing season, growing conditions and cultivars.

3.4 Population fluctuation of Thrips, *Scirtothrips dorsalis* (Hood) infesting Bt cotton (cv. Suraj) during *Rabi* season 2017-18.

The similar trend of result was observed in second year experiment during 2017-18. The abundance of thrips population is dramatically changes in weather factors. However, during the period of investigation, thrips population was ranged from 0.5-139.25 per leaf and this pest started to appear during 8th standard meteorological week (Fig 4). The population of thrips was gradually increased and observed its peak activity in 13th standard meteorological week (139.25 thrips per leaf) whereas least population (0.5 thrips per leaf) was observed in 19th SMW. The present findings are supporting the results (Shivanna *et al*., 2009) [14] reported that the maximum incidence of thrips population was noticed from 13th SMW to 19th SMW with a peak incidence of 26.81 per three leaves was recorded in April second fortnight. Correlation between thrips population (Table 4) and different weather parameters revealed that the maximum temperature (r= 0.43), minimum temperature (r= 0.53), minimum relative humidity (r= 0.22) and total rainfall (r= 0.80) showed positive impact on population build-up of thrips and maximum relative humidity (r = -0.37) and bright sunshine hours (r = -0.37) exhibited negative impact on population build-up of thrips population in plains of West Bengal (Table 4). The present finding partial agreement with the reports of (Prashant *et. al*., 2018) [15] reported that the maximum temperature was non-significant positive correlated (r=0.124) with thrips population but minimum temperature was significant positive (r=0.784) correlation with thrips population.

Table 1: Correlation and Regression Coefficient of whitefly, *Bemisia tabaci* (Gennadius) in Bt cotton with weather factors during *Rabi* season 2016- 17.

Weather parameters	Correlation(r)	Regression Equation
Max. Temperature (^{0}C)	0.76	$y = -0.789x^2 + 50.557x - 775.36$ $R^2 = 0.5855$
Min. Temperature (^{0}C)	0.56	$y = -0.2396x^2 + 8.9112x - 49.764$ $R^2 = 0.3256$
Max. Relative Humidity (%)	0.42	$y = 0.6698x^2 - 120.76x + 5465.1$ $R^2 = 0.1791$
Min. Relative humidity (%)	-0.31	$y = 0.0106x^2 - 1.4823x + 71.838$ $R^2 = 0.1045$
Total Rainfall (mm)	-0.63	$y = 0.3289x^2 - 5.2426x + 29.053$ $R^2 = 0.4102$
Bright sunshine hour (hrs)	-0.45	$y = 2.3831x^2 - 35.355x + 150.96$ $R^2 = 0.206$

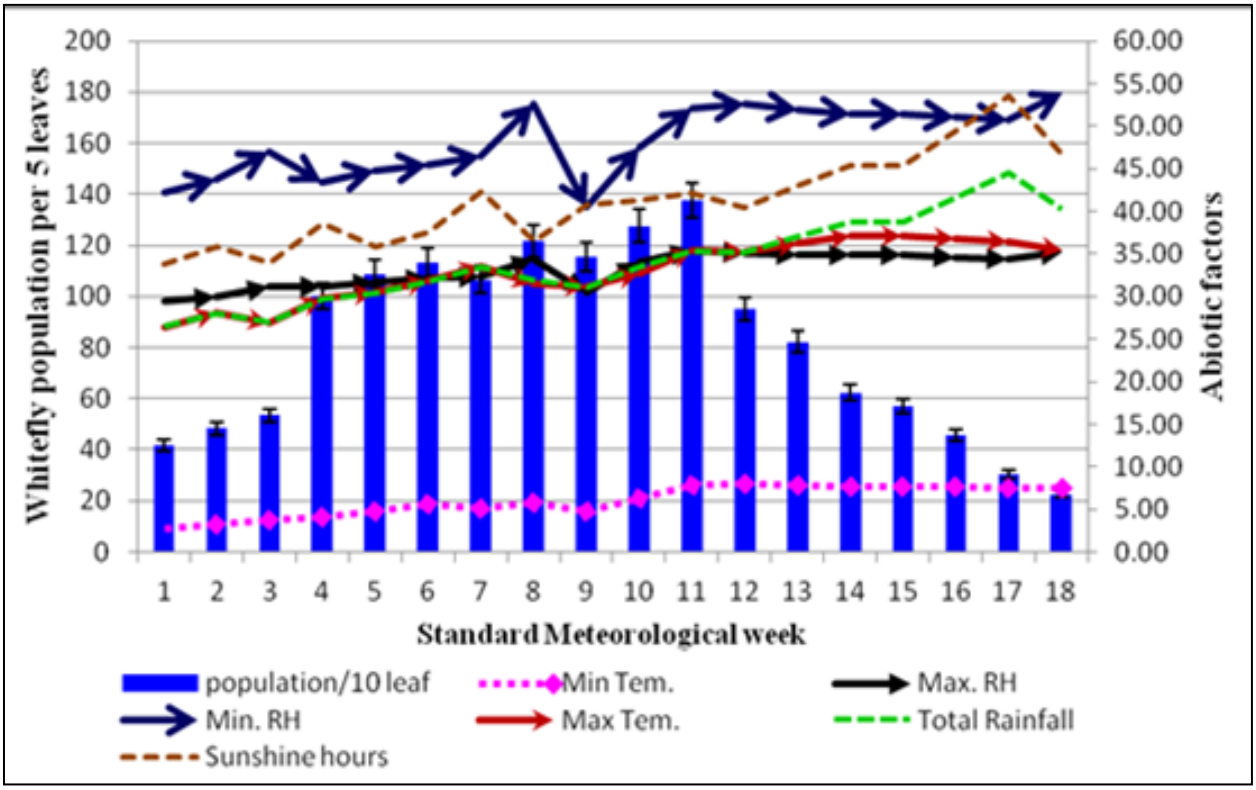

Fig 1: Population fluctuation of whitefly, *Bemisia tabaci* (Gennadius) infesting Bt cotton (cv. Suraj) during *Rabi* season 2016- 17.

Table 2: Correlation and Regression Coefficient of whitefly, *Bemisia tabaci* (Gennadius) in Bt cotton with weather factors during Rabi season 2017-18.

Weather parameters	Correlation(r)	Regression Equation
Max. Temperature (^{0}C)	0.52	$y = -0.4107x^2 + 26.579x - 402.41$ $R^2 = 0.2804$
Min. Temperature (^{0}C)	0.70	$y = -0.2828x^2 + 10.231x - 61.348$ $R^2 = 0.5042$
Max.Relative Humidity (%)	-0.23	$y = 0.4753x^2 - 84.388x + 3765.1$ $R^2 = 0.0563$
Min. Relative humidity (%)	0.41	$y = -0.0073x^2 + 0.2321x + 28.14$ $R^2 = 0.1627$
Total Rainfall (mm)	-0.40	$y = 2.0812x^2 - 11.633x + 24.924$ $R^2 = 0.1668$
Bright sunshine hour	-0.70	$y = 6.1409x^2 - 90.352x + 347.64$ $R^2 = 0.4973$

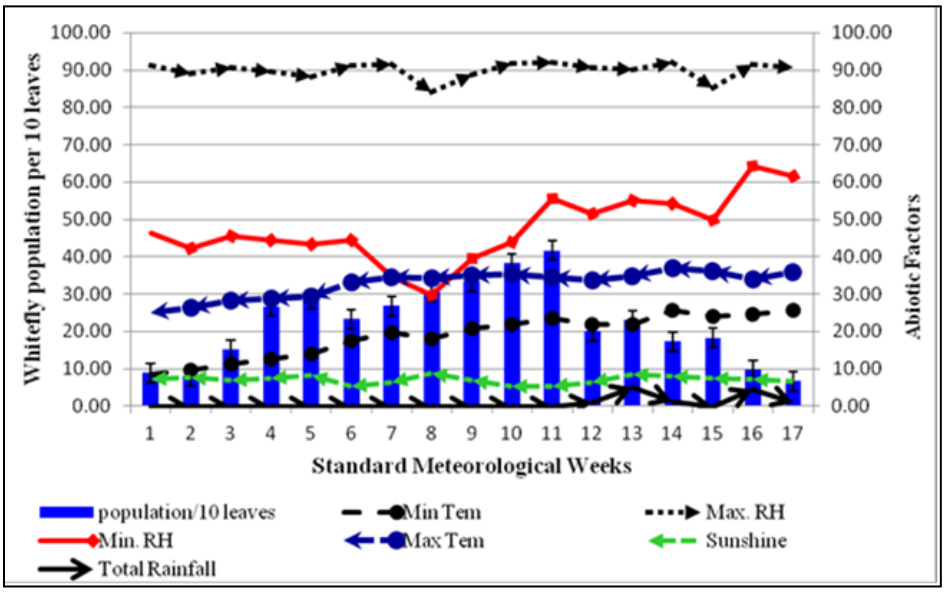

Fig 2: Population fluctuation of whitefly, *Bemisia tabaci* (Gennadius) *infesting* Bt cotton (cv. Suraj) during *Rabi* season 2017-18.

Table 3: Correlation and Regression Coefficient of Thrips, *Scirtothrips dorsalis* (Hood) in Bt cotton with weather factors during *Rabi* season 2016- 2017.

Weather parameters	Correlation(r)	Regression Equation
Max. Temperature (^{0}C)	0.41	$y = -2.0371x^2 + 145.21x - 2518.1$ $R^2 = 0.1691$
Min. Temperature (^{0}C)	-0.57	$y = 0.9851x^2 - 34.23x + 310.6$ $R^2 = 0.3274$
Max. Relative Humidity (%)	0.63	$y = -0.3424x^2 + 60.643x - 2631.3$ $R^2 = 0.0045$
Min. Relative humidity (%)	-0.26	$y = 0.0385x^2 - 2.0369x + 51.744$ $R^2 = 0.068$
Total Rainfall (mm)	0.35	$y = -1.6359x^2 + 4.1364x + 57.698$ $R^2 = 0.1247$
Bright sunshine hour (hrs)	-0.32	$y = -0.6764x^2 - 2.0828x + 100.54$ $R^2 = 0.1047$

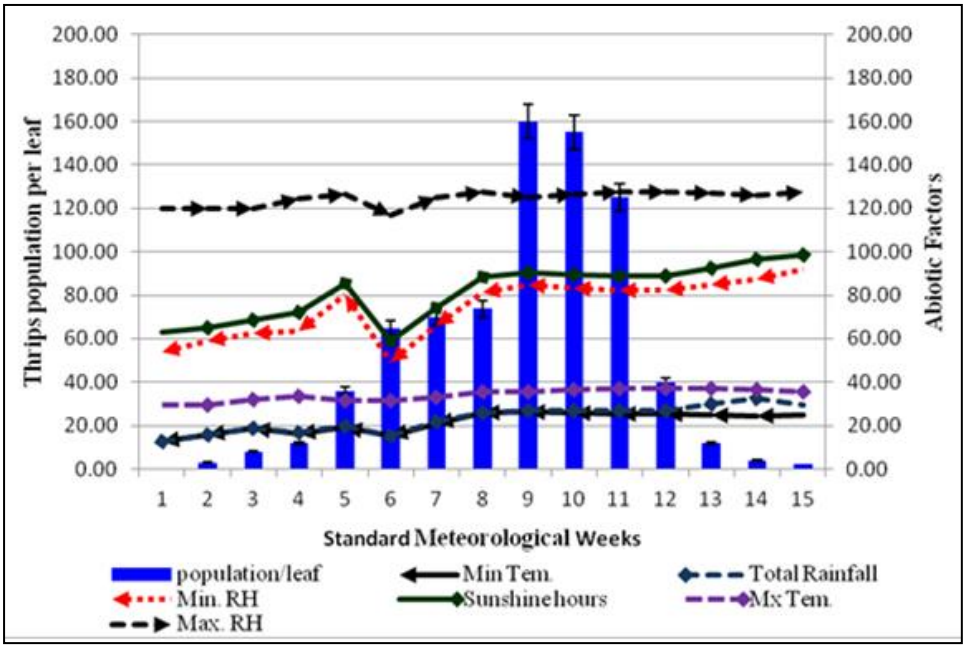

Fig 3: Population fluctuation of Thrips, *Scirtothrips dorsalis* (Hood) infesting Bt cotton (cv. Suraj) during *Rabi* season 2016- 17.

Table 4: Correlation and Regression Coefficient of Thrips, *Scirtothrips dorsalis* (Hood) in Bt cotton with weather factors during Rabi season 2017- 2018.

Weather parameters	Correlation(r)	Regression Coefficient (X)
Max. Temperature (^{0}C)	0.43	$y = -2.13x^2 + 146.03x - 2447.7$ $R^2 = 0.1935$
Min. Temperature (^{0}C)	0.53	$y = -1.1799x^2 + 49.637x - 459.03$ $R^2 = 0.2895$
Max. Relative Humidity (%)	-0.37	$y = 2.1669x^2 - 377.85x + 16490$ $R^2 = 0.14$
Min. Relative humidity (%)	0.22	$y = -0.0937x^2 + 9.1453x - 170.28$ $R^2 = 0.0505$
Total Rainfall (mm)	0.08	$y = 0.3232x^2 + 0.7535x + 42.585$ $R^2 = 0.0075$
Bright sunshine hour	-0.53	$y = 18.078x^2 - 269.18x + 1021.8$ $R^2 = 0.2851$

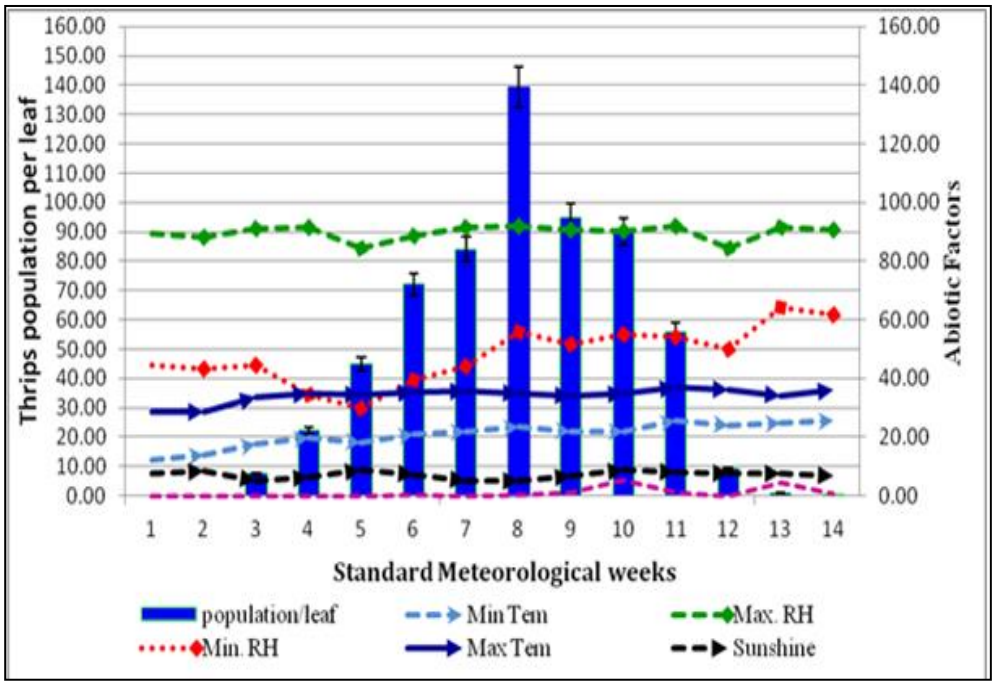

Fig 4: Population fluctuation of Thrips *Scirtothrips dorsalis* (Hood) infesting Bt cotton (cv. Suraj) during Rabi season 2017-18.

4. Conclusion

According to two years average data, whitefly infestation was first recorded in 3rd standard meteorological week (SMW) of the crop and continued up to 15th SMW. However, it reached its peak population in 13th SMW with a population 41.30 per 5 leaves. The thrips population first commenced at 7th standard meteorological week, maximum population (160.0 thrips per leaf) was recorded on 14th SMW and least population (2.30 thrips/leaf) was recorded on 20th SMW. Among the weather factors maximum temperature showed positive correlation whitefly, *B. tabaci* and thrips, *S. dorsalis* population The rainfall is favorable the activity of whitefly whereas the thrips population was unaffected by the rainfall.

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