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Population dynamics of whitefly, *Bemisia tabaci* (Gennadius), as influenced by weather conditions infesting *Bt* cotton hybrid

SANJEEV KUMAR KATARIA[1*], RAJ KUMAR PAL[2], VINEET KUMAR[2] and PARAMJIT SINGH[2]

[1]*Punjab Agricultural University, Farm Advisory Service Centre, Nurmahal, Jalandhar-144039, Punjab*
[2]*Punjab Agricultural University, Regional Research Station, Bathinda-151001, Punjab*
**Corresponding author's email: k.sanjeev@pau.edu*

ABSTRACT

To quantify the effect of different sowing environments and weather conditions on incidence of whitefly on cotton, experiments were conducted at PAU Regional Research Station, Bathinda during *kharif* 2014-2017) with *Bt* cotton hybrids 'NCS-855 BGII' at normal and late sowing. The mean incidence of whitefly was ranged from 0.0–39.5, 11.2–124.0, 0.2–26.4 and 0.7–15.5 adults/leaf during 2014, 2015, 2016 and 2017, respectively. The maximum adult population of whitefly was recorded in month of August almost in all the years, having its peak between 31–34 standard meteorological weeks (SMW). Among years, whitefly population was negatively correlated with rainfall, morning and evening relative humidity, while positively correlated with maximum temperature (except 2014) and minimum temperature (except 2014 and 2017). Moreover, bright sunshine showed positive correlation with whitefly population. In respect of pooled data, whitefly population showed negative correlation for minimum and maximum temperature and rainfall, while, positive correlation with morning and evening relative humidity and bright sunshine hours. Overall, crop sown at normal date was less affected by infestation of whitefly than late sown crop. So, this information would be helpful in developing efficient pest management strategies on cotton crop in order to get good harvest.

***Key words**: Bt* cotton, dates of sowing, whitefly, weather parameters.

Cotton (*Gossypium* spp.) is a leading cash crop of Punjab widely known as the "White Gold. It is grown commercially in a wide range from temperate to tropical regions. Cotton is also known for its oil content properties, providing raw material to the oil and textile industries, contributes to approximately 30 per cent of the Indian agricultural, gross domestic product and considerable export earnings (Rohini *et al.,* 2011). In world, the area under cotton was 292.23 lakh ha with a production of 105.72 million bales of 480 lb and productivity of 788 kg ha^{-1} (Prakash *et al.,* 2017). Cotton cultivation is a very important part of the Indian agrarian landscape and provides sustainable livelihood to a sizeable population in India devotes more land to cotton than any other country in the world and today ranks first in area with 11.88 m ha^{-1} accounting 30 per cent of world coverage and 22 per cent (351 lakh bales of lint) of the world cotton production and productivity of 568.29 kg ha^{-1} (Kannan *et al.,* 2017; Janu and Dahiya, 2017). It is estimated that more than 5.8 million farmers cultivate cotton in India and about 40–50 million people are employed directly or indirectly by the cotton industry (Kannan *et al*., 2017). During the year 2016-17, the annual provisional production of cotton was 9.00 lakh bales of 170kg which have grown in an area of 2.56 lakh hectares in Punjab state (Anon, 2016).

Amongst the sap sucking insect pests damaging this crop, whitefly, *B. tabaci* (Hemiptera: Aleyrodidae), a highly polyphagous insect-pest, has become serious, causing heavy losses during certain years. High population of the pest has the potential to remove significant amounts of phloem sap resulting in the reduction of plant vigour. Damage by this pest is caused in two ways: (a) the vitality of the plant is lowered through the loss of cell sap, and (b) normal photosynthesis is interfering with the growth of sooty mould on the honeydew excreted by the insect. Due to sooty mould growth, the quality and marketability of harvested products are reduces (Oliveira *et al.,* 2001).

Honeydew falling on open bolls makes the lint sticky, which creates problems during ginning (Hendrix *et al.,* 1996). The pest is also known to transmit cotton leaf curl virus causing significant yield losses if the infection is in the early stages of crop growth (Duffus, 1987). Due to variation in the agro-climatic conditions of different seasons insect show varying trends in their incidence also in nature and extent of damage to the crops (Fand *et al.,* 2018; Rolania *et al.,* 2018; Sharma et *al.,* 2018; Dhawan *et al.,* 2009). Besides, some known and unknown factors also play a key role in

determining the incidence and dominance of a pest. Therefore, the present study was to understand the behaviour of whitefly with the weather parameter of the environment.

The lower production and productivity of cotton is depend on several factors but the magnitude of insect pests that damage cotton crop from sowing to maturity is most important (Dhawan *et al.,* 2009). Cotton crop is vulnerable to the attack of many insect pests, which cause heavy qualitative and quantitative losses. In India, out of 162 insect pests attacking cotton, nine are considered as key pests in different zones resulting in 50-60 % loss in seed cotton yield (Dhawan, 2004).

Among several insect pests, whitefly has assumed the status of a serious pest of cotton. Because of the unexpected variations in weather from wet towards dry conditions and indiscriminate use of conventional insecticides, the importance of whitefly as a pest of economic importance in different ecosystems has expanded. Also, due to the reduction of broad-spectrum insecticides in *Bt* cotton, whitefly survive better and reach a pest status and is known to infest more than 600 plant species (Stansly and Naranjo, 2010).

Under changed climatic conditions and with the introduction of *Bt* cotton, importance of whitefly has increased during the last 7-8 years. Keeping in view its status as a pest, the main aim of the present study was to study the infestation of whitefly adults during crop growing period of *Bt* cotton as affected by sowing environments and hybrids.

MATERIALS AND METHODS

In order to quantify the effect of different sowing environments and weather conditions on incidence of whitefly of *Bt* cotton hybrids, the experiments were laid out at Jodhpur Farm, Punjab Agricultural University Regional Research Station, Bathinda (30° 09" N, 74 ° 55" E and 211 m amsl) in *Kharif* for four consequent growing seasons (2014, 2015, 2016 and 2017) with the *Bt* cotton hybrids 'NCS 855 BGII' at normal (Second week of May) and late sowing (Last week of May) in complete randomized block design with three replications in a factorial arrangement. Pooled data of both *Bt* cotton hybrids were used for the study. The agro-meteorological data of minimum & maximum temperature, morning & evening relative humidity (RH) and rainfall were obtained from the Agrometeorological Observatory of Punjab Agricultural University, Regional Research Station, Bathinda.

The population of whitefly was estimated from 5 plants selected randomly in each plot, thereafter, from each plant, 3 fully formed leaves of the upper canopy were used to estimate whitefly population and converted to mean population by averaging them. The observations on population of adult whitefly were recorded at weekly intervals from 27 to 39 SMW before 10:00 AM. The mean population data obtained from various SMW were subjected to simple correlation analysis with meteorological parameters, viz. maximum and minimum temperature, morning and evening relative humidity and rainfall. Data was analyzed statistically by SPSS software and simple correlation was worked out between the population of insect pests and weather parameters (maximum and minimum temperature, morning and evening relative humidity and rainfall) by the Karl Pearson's coefficient of correlation (Chee, 2015) at 5% level of significance.

RESULTS AND DISCUSSION

Population dynamics of whitefly

Kharif 2014 : Whitefly adult population ranged from 0.0–36.7 and 0.0–42.3/leaf under normal and late sown crop, respectively and 0.0–39.5/leaf for pooled data. Moreover, maximum whitefly adult population was recorded at 38th standard meteorological week (SMW) in second fortnight of September. Maximum and Minimum temperature, Morning & Evening relative humidity were observed as 35.2°C, 23.6°C, 86% and 46%, respectively with no rainfall. In the year of 2014, the maximum and minimum temperatures ranged 32.6–41.1 °C and 23.0–29.6°C; however, morning and evening relative humidity were observed between 68– 65% and 35–63%, respectively. During crop growing period sunshine ranged 4.7 – 8.0 hr/day, while a total of 212.8mm rainfall was recorded during the period (Fig. 1 and 3). Results of Devi and Ram (2018), Kataria and Pal (2014) and Karavina *et al.,* (2012) also showed that the population of whitefly adults was highest in late sown and least in early sown cotton crop.

Kharif 2015 : Maximum whitefly incidence was noticed in the crop sown in last week of May throughout the crop season followed by normal sown i.e. in second week of May. Whitefly population reached its peak at 34th SMW (135.2 whitefly/leaf) in the second fortnight of August. Kataria and Pal (2014) also indicated that the whitefly population reaches at the peak at the flowering stage of the crop i.e. in second fortnight of August. Due to some weather abnormalities, among the years and sowing environments of study period, the highest whitefly population was observed throughout the crop season in 2015. The whitefly adult population in 2015 was observed between 10.2–112.7, 12.2–135.2 and 11.2–124.0 whiteflies/leaf for normal sown, late sown and pooled data, respectively. Higher infestations of whitefly with late sown crop were also reported

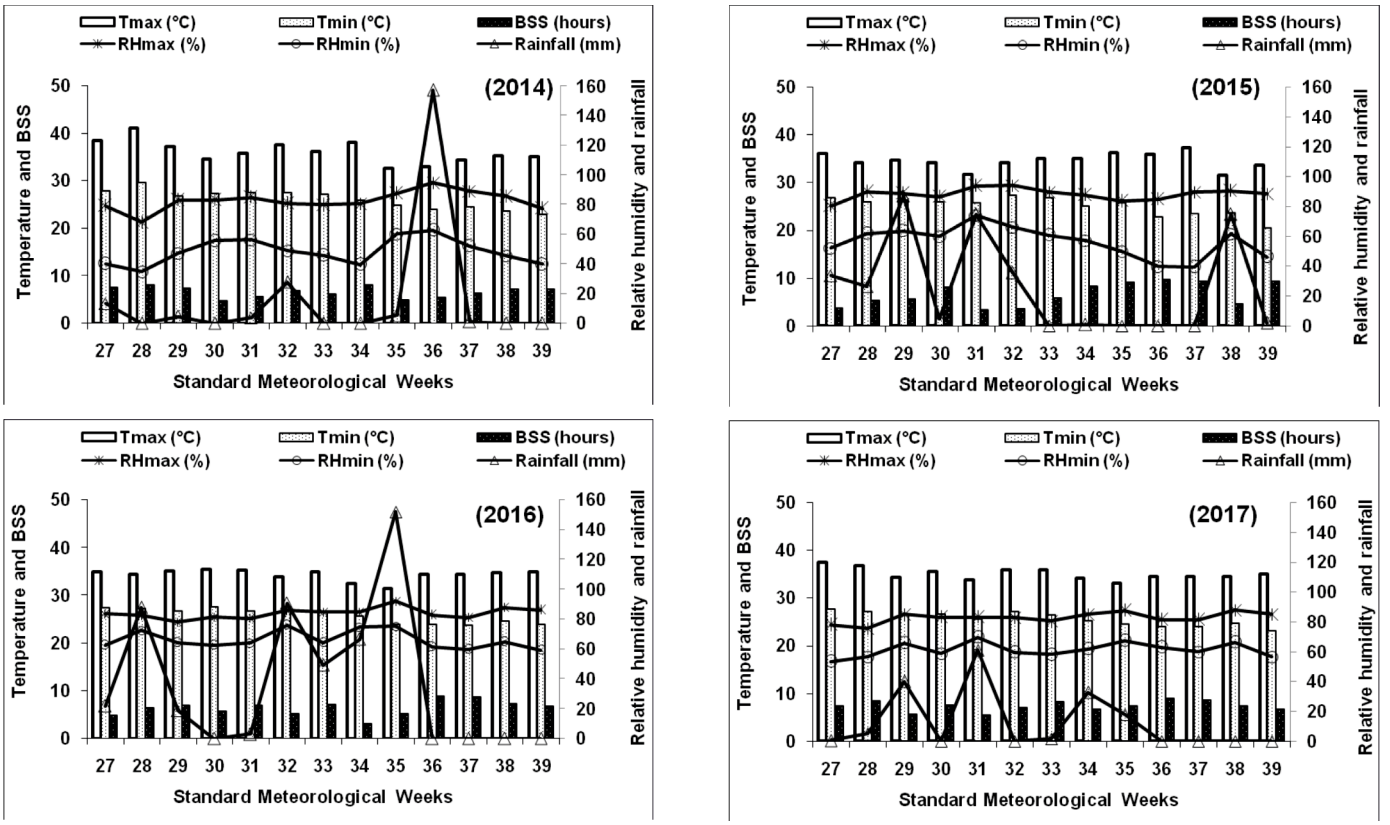

Fig.1: Weather conditions during cotton study period and their effect on average population of whitefly during crop growing period (2014 to 2017)

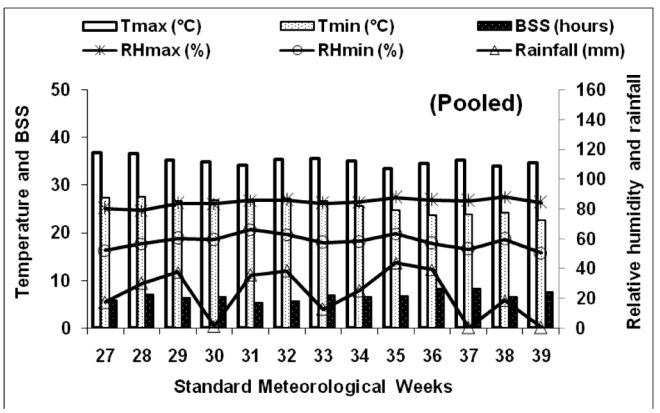

Fig.2: Mean weather conditions from 2014 to 2017 and their effect on average population of whitefly during crop growing period

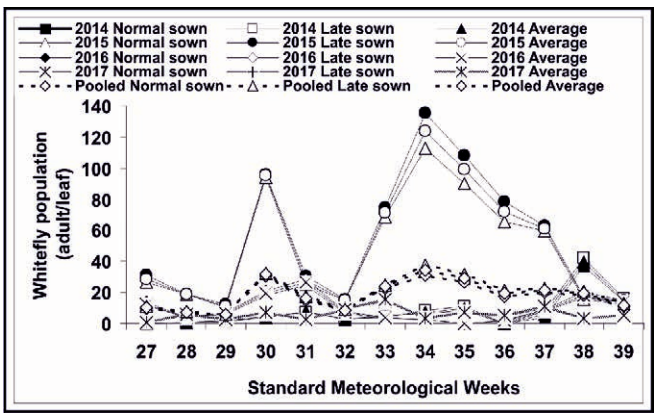

Fig.3: Population variation of whitefly on *Bt* cotton hybrid during crop growing period from 2014 to 2017 as affected by different sowing environments.

by Devi and Ram (2018), Kataria and Pal (2014) and Karavina *et al.,* (2012). Moreover, mean temperature and mean relative humidity was recorded between 27.1–31.4 °C and 52–84 %, respectively, during the crop season, while, sunshine was observed in the range 3.4 – 9.7 hours/day with a sum of 340 mm rainfall during crop growing period (Fig. 1 and 3).

Kharif 2016 : Among stages of the crop, maximum whitefly adult's population (24.6 and 28.3adults/leaf for normal and late sown, respectively) was observed at 31st SMW. Because of heavy rainfall received between 32nd to 35th SMW (more than 350 mm) during the period (which is generally favorable period for whitefly infestation), the whitefly adults population was washed out and observed below Economic Threshold Level (ETL). During crop growing period of 2016, the population of whitefly adult's was ranged from 0.0–24.6, 0.3–28.3 and 0.2–26.4 adults/leaf with normal sown, late sown and pooled data, respectively. During crop growing period,

Table 1: Correlation coefficients between meteorological parameters and whitefly population on *Bt* cotton hybrid as affected by different sowing environments from 2014 – 2017.

	2014			2015			2016			2017			Pooled		
	Normal	Late	Average	Normal	Late	Average	Normal	Late	Average	Normal	Late	Average	Normal	Late	Average
Tmax (°C)	-0.25	-0.27	-0.26	0.46	0.46	0.46	0.65*	0.63*	0.64*	0.06	0.08	0.07	-0.47	-0.50	-0.49
Tmin (°C)	-0.55*	-0.59*	-0.57*	0.06	0.04	0.05	0.27	0.26	0.26	-0.02	-0.06	-0.04	-0.21	-0.26	-0.24
RHmax (%)	0.11	0.14	0.13	-0.39	-0.41	-0.40	-0.26	-0.25	-0.26	-0.11	-0.17	-0.14	0.37	0.40	0.39
RHmin (%)	-0.09	-0.09	-0.09	-0.29	-0.30	-0.30	-0.47	-0.46	-0.46	-0.20	-0.25	-0.23	0.15	0.15	0.15
BSS (hrs)	0.09	0.10	0.09	0.59*	0.60*	0.60*	0.11	0.11	0.11	0.47	0.53*	0.51	0.15	0.17	0.16
Rainfall (mm)	-0.26	-0.27	-0.27	-0.67*	-0.66*	-0.67*	-0.62*	-0.61*	-0.61*	-0.40	-0.43	-0.42	-0.25	-0.19	-0.22

*Significance level at 0.05P.

mean temperature, mean relative humidity were in the range between 27.7–31.5 °C and 71–84%, respectively. A sum of 490.3 rainfall was received during crop period, sunshine was observed between 3.1–8.8 hours/day (Fig. 1 and 3).

Kharif 2017 : Data revealed that the higher infestation of whitefly adult's was noticed at 33rd SMW (14.2 and 16.8 adults/leaf with normal and late sown, respectively), while minimum was observed at the initial stage of the crop. The whitefly population was observed in the range between 0.7–14.2, 0.8–16.8 and 0.7–15.5 for normal sown, late sown and pooled data, respectively. Throughout the crop period, among the years of study, the lowest whitefly adult's population was occurred in the year 2017 due to proper distribution of rainfall during the crop period, even the total rainfall was less (159.1mm) than the other years. Devi and Ram (2018) also reported less whitefly infestation during 2017 than 2016 with normal as well as late sown crop, it may be due to proper rainfall distribution. Moreover, mean temperature, mean relative humidity and sunshine were recorded in the range between 28.8–32.5 °C, 66–78 % and 5.7–9.0 hours/day (Fig. 1 and 3).

Pooled data

Pooled data of whitefly population of all the four consequent cotton growing seasons (i.e. 2014, 2015, 2016 and 2017) was ranged 5.1–31.1 and 6.0–37.5 for normal and late sown crop, respectively, having its peak at 34th SMW in second fortnight of August. Results of Devi and Ram (2018) and Kataria and Pal (2014) also revealed that maximum whitefly population was observed in second fortnight of August. Mean of four years of maximum and minimum temperatures ranged between 34.0–36.7 °C and 22.7–27.5 °C, respectively, while sunshine was recorded between 5.4–8.2 hours/day. Morning and evening relative humidity were observed in the ranged from 79–88 and 51–66 per cent, respectively. Among the years, minimum rainfall (159.1 mm) was received in 2017, while maximum (490.3 mm) in 2016 (Fig. 2 and 3).

Correlation analysis

Impact of weather parameters on population dynamics of whitefly was analyzed in terms of correlation in all the years of study including pooled data and presented in Table 1. Among the years and growing environments, whitefly population was negatively correlated with evening relative humidity including pooled data and morning relative humidity also showed negative correlation expect the year 2014 and pooled data. During all the years of study and with growing environments, rainfall indicated significantly negative correlation during 2016 and 2017 followed by rest of the years including pooled data. Moreover, bright sunshine hours had positive correlation with whitefly population having significant positive in 2015, while, pooled data of the same was indicated negative correlation. During the years 2015 and 2016, maximum and minimum temperature showed positive correlation, while, it was negatively associated with rest of the years including pooled data. Study of Selvaraj *et al*., 2011 indicated that, maximum temperature was negatively with whitefly population for all treatments. On the other hand, minimum temperature, morning and evening relative humidity indicated almost positive correlation (Purohit *et al.,* 2006) for all sowing dates, varieties and N-fertilizers levels. Moreover, rainfall was negatively correlated with whitefly

adult population in all treatments (Mahmood *et al.,* 2002). Study of Kataria and Pal, 2014 also showed that, whitefly adult's population showed positive correlation with minimum temperature and relative humidity, whereas, Prasad *et al.,* (2008) Kataria and Pal (2014) reported that the whitefly population was negatively associated with maximum temperature and rainfall.

CONCLUSION

During the study period, low population of whitefly adults were observed in early sown crop. However, among the years and crop growing periods, highest population was build up in the month of August. The whitefly population was negatively correlated with rainfall, morning & evening relative humidity in all the years under study except 2014 and for morning relative humidity including the pooled data. Moreover, bright sunshine hours indicated positive correlation with whitefly population including pooled data throughout the years. Pooled data of whitefly population showed negative correlation with minimum and maximum temperature. Overall, crop sown at normal date (first week of May) was less affected by infestation of whitefly as compared to late sown crop. This information is helpful for revising the crop calendar as well as for developing efficient pest management strategies for cotton crop in semi-arid track of Punjab and similar agro-ecological regions.

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