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Seasonal incidence of whitefly, *Bemisia tabaci* on Bt cotton in relation to weather parameters

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Abstract
The field experiments was carried out on seasonal incidence of whitefly, *Bemisia tabaci* on Bt cotton in relation to weather parameters at the Research farm College of Agriculture, Swami Keshwanand Rajasthan Agricultural University Bikaner, (Rajasthan) during Kharif, 2018. The occurrence of whitefly, *Bemisia tabaci* on Bt cotton was started in the 26th standard meteorological week which was last week of June and remained until 44th standard meteorological week which was first week of November. Initially, the population of whitefly, *B. tabaci* was recorded low but gradually increased week after week and attained to its peak in 38th standard meteorological week, which was the third week of September. After its peak population, the population of whitefly, *B. tabaci* was declined gradually week after week and after the 44th standard meteorological week which was first week of November there is no population occurred on Bt cotton. The maximum temperature showed non-significant positive correlation with incidence of whitefly, *B. tabaci* on Bt cotton. The minimum temperature showed non-significant negative correlation of with incidence of whitefly, *B. tabaci* on Bt cotton. Morning relative humidity showed significant negative correlation with incidence of whitefly, *B. tabaci* on Bt cotton while, evening relative humidity showed non-significant negative correlation with incidence of whitefly, *B. tabaci* on Bt cotton. Rainfall showed non-significant negative correlation with incidence of whitefly, *B. tabaci* on Bt cotton. These findings are useful for effective pest management in Bt cotton crop.

Keywords: Seasonal incidence, *Bemisia tabaci*, whitefly, weather parameters

Introduction
Cotton is one of the major fiber and cash crops of all around world. It is grown under tropical and subtropical regions of more than 80 countries of world occupying 31.8 million hectare area with the production of 24963 million bales globally (ICAC, 2018) [11]. China, U.S.A., India, Pakistan, Uzbekistan, Australia, Brazil, Greece, Argentina and Egypt are main cotton producing countries. An approximately 85% of the overall cotton production contribute by these countries. In India, cotton is being cultivated in 122.35 lakh hectares and production of 377.00 lakh bales (one bale of 170 kg) of cotton lint with an average productivity of 524 kg/ha. In Rajasthan, the area under cotton cultivation is 5.03 lakh ha with production of 22.00 lakh bales with an average productivity of 744.00 kg/ha during 2018 (Anonymous., 2018) [2, 3]. More than 1300 pest species were found to be associated with cotton crop world-wide and caused deterioration in lint quality and production losses to the tune of 10 - 40 Per cent in the non-transgenic cotton (Gahukar, 2006) [10]. In India, out of 162 insect pests attacking cotton, nine are considered as key pests resulting in 50-60 Per cent loss in seed cotton yield (Dhawan, 2004) [9]. The primary pest complex includes bollworm (BW) *viz*. American bollworm, *Helicoverpa armigera* (Hub.); spotted bollworms, *Earias insulana* (Boisd.) and *E. vitella* (Fab.); pink bollworm, *Pectinophora gossypiella* (Saund.); and the secondary pest complex includes whitefly, *Bemisia tabaci* (Gen.); jassid, *Amrasca bigutulla biguttula* (Ishida) and thrips, *Thrips tabaci* (Lind.) have been causing serious threat to the non-transgenic cotton (Dhaka and Pareek, 2007) [7]. However, the adoption of Bt cotton (Bt cotton is genetically modified cotton crop that expresses an insecticidal protein whose gene has been derived from a soil bacterium called Bacillus thuringiensis, commonly referred as Bt) in India solved the problem of bollworms to large extent, but due to changed cropping system and increase in transgenic cotton area, resulted in outbreak of the secondary pest's *viz*. whitefly, jassids and thrips incidence (Singh, 2018) [20]. Although introduction of Bt cotton could reduce the bollworm incidence, number of other pests *viz*., whitefly, leafhopper, mirid bugs, aphids and thrips are becoming potential threats (Kranthi *et al*., 2011) [12, 13]. Among them whitefly is most destructive sucking pest of cotton.

Whitefly is widely distributed polyphagous pest in tropical and subtropical regions of India. Whitefly nymph is greenish, oval in shape, present on the under surface of the leaves and the adult is minute insects with yellow body covered with a white waxy bloom. Both adult and nymph suck the cell sap from phloem by secreting honey dew, causes weakening and dryness of plant. *B. tabaci* also transmit a number of viral diseases like as cotton leaf curl, leaf curl of tobacco, yellow mosaic virus of moongbean and leaf curl disease of sesame.

The insect pest populations are being maintained below economic threshold levels using different control tactics but the indiscriminate and injudicious use of insecticides has resulted in to severe problems like pest resurgence, pest resistance pesticide residues, toxicity to non target organisms and environmental pollution etc. However, detailed studies on the influence of abiotic factors on the incidence of whitefly under the agro-climatic conditions on *Bt* cotton is lacking and it is needed to sort out the precise nature or extent of relationship, which exists between whitefly population and weather factors to determine pest status and to formulate effective pest control strategies for sustainable management of this pest.

Materials and methods

Present investigation on seasonal incidence of whitefly, *B. tabaci* were recorded on Bt cotton hybrid (NCS 855 BG II) at the Research farm College of Agriculture, Swami Keshwanand Rajasthan Agricultural University Bikaner, (Rajasthan) during *Kharif*, 2018 crop seasons. Bt cotton hybrid (NCS 855 BG II) was sown during 22-May 2018 in a plot of 1000 m^2. The recommended package of practices, except spraying of insecticides was followed for raising the crop (Anonymous, 2018) [2, 3]. The populations of whitefly, *B. tabaci* were recorded on five randomly selected tagged plants in morning hours (Before 8 AM), when insects has minimum activity. The observations were recorded on whole plant in the initial stage and on six leaves two from from upper, middle and lower portion of randomly selected and tagged plants. The population was counted by holding the base of leaves gently until the entire underside of leaf was clearly visible. Population was estimated with least disturbance at early hours of the day. From this, the average population per leaf was worked out. The data on various meteorological parameters were obtained from Agriculture Research Station, Swami Keshwanand Rajasthan Agricultural University Bikaner. The mean population data obtained from weekly observations were subjected to simple correlation analysis with weather parameters, *viz*., maximum and minimum temperature, morning and evening relative humidity, and rainfall.

Results and discussion

Incidence of whitefly, *B. tabaci*

Data presented in Table-1 depicted that during 2018, the population of whitefly, *B. tacaci* throughout the season was ranged between 3.98 to 52.12/ three leaves. The whitefly, *B. tacaci* appeared on the crop in 25th standard meteorological week (10.12/3 leaves) i.e. third week of June when the corresponding average maximum and minimum atmospheric temperatures were 41.8 °C and 28.0 °C, morning and evening R. H. was 61.1 and 34.3% and 8.22 mm rainfall. The similar results were found in investigation of Dhaka and Pareek (2008) [6] who reported that whitefly, *B. tabaci* appeared in June. The population of whitefly was noticed above economic threshold level (ETL) from 35th standard week to 42thstandard week i.e. from last week of August to last week of October. The peak activity of whitefly, *B tabaci* (52.12/3 leaves) was recorded in 38th standard week, i.e. third week of September when the coinciding average maximum and minimum atmospheric temperatures, morning and evening relative humidity were 36.9 and 23.1 °C, 65.1 and 39.4% and no rainfall, respectively. The similar results were found in investigations of Purohit (2006) [16] who reported that whitefly, *B. tabaci* attained to its peak population in third week of September. Similar results were also observed by Acharya and Singh (2007) [1] who reported that incidence of whitefly, *B. tabaci* reached to its peak in the month of September. The results are in agreement to those of Nagar (2017) [14] who revealed that whitefly, *B. tabaci* reached to its peak in 38th standard meteorological week. Swati and Krishna (2017) [21] also observed that two peaks of whitefly, *B. tabaci* adults, the first was in third week of August and second in third week of September similarly Nemade (2018) [15] revealed that the maximum population of adults of whitefly, *B. tabaci* noticed in second week of September support the present finding. After the peak the population whitefly, *B. tabaci* decline gradually week after week and disappeared after the 44th standard meteorological week.

3.2 *B. tabaci* population in relation to weather parameters

The data presented in Table- 2 revealed that the maximum temperature showed non-significant positive correlation (r= 0.104), whereas, negative non-significant correlation (r= -0.290) with minimum temperature and whitefly, *B. tabaci*. The results also indicated that morning relative humidity had significant negative correlation with the population of whitefly, *B. tabaci* (r= -0.506) while evening relative humidity non-significant negatively correlated (r= -0.419) with population of whitefly, *B. tabaci*. The rainfall showed non-significant negative correlation (r=-0.336) with the incidence of whitefly, *B. tabaci.* These results can be compared with the results of Nemade (2018) [15] and Dhandge (2018) [8] reported that maximum temperature had a non-significant positive correlation with incidence of whitefly, *B. tabaci*. Shivana (2011) [19], Boda and llyas (2017) [5] reported that the minimum temperature had a non-significant positive correlation with incidence of whitefly, *B. tabaci*. Bhute (2012) [4], Sharma and Sharan (2016) [18] found that morning relative humidity showed significant and negative correlation with incidence of whitefly, *B. tabaci*. Dhandge (2018) [8] revealed that the evening relative humidity had a non-significant negative correlation with the incidence of whitefly, *B. tabaci*. Boda and llyas (2017) [5] and Nemade (2018) [15] found that the rainfall favored the activity of all sucking pests with positive correlation except whitefly, *B. tabaci*

The incidence of whitefly started in last week of June and remained up to the last picking of cotton with peak activity recorded in the last week of September thereafter declined gradually. The correlation study between incidence of whitefly, *B. tabaci* and abiotic factors revealed that maximum atmospheric temperature had non-significant positive correlation. Minimum atmospheric temperature had non-significant negative correlation with the population of whitefly, *B. tabaci* on Bt cotton, Whereas, morning R.H. had shown significant negative effect and evening R.H. had non-significantly negative effect on whitefly, *B. tabaci* population throughout the season. The rainfall had non-significant negative effect on whitefly, *B. tabaci* population.

Table 1: Seasonal incidence of whitefly, *B. tabaci* on Bt cotton during *Kharif*, 2018.

SMW*	Temperature (°C)		Relative Humidity (%)		Total Rainfall (mm.)	Mean Whitefly population/3 leaves
	Max.	Min.	Morning	Evening		
25	41.8	28.0	61.1	34.3	8.2	10.12
26	35.7	26.1	77.3	56.6	34.6	5.08
27	40.0	29.5	71.6	40.0	0.0	14.97
28	40.9	29.9	91.9	42.9	14.4	8.15
29	35.2	26.5	86.7	67.0	162.6	8.12
30	35.0	26.8	88.4	58.9	12.8	8.01
31	36.5	26.9	89.1	43.6	0.0	6.11
32	36.1	26.8	88.1	53.6	10.2	9.16
33	36.3	26.9	80.1	51.7	6.6	13.21
34	35.2	25.8	81.3	54.4	38.0	11.13
35	36.7	26.5	73.1	47.3	0.0	34.25
36	35.5	25.9	72.0	48.4	0.0	42.56
37	36.1	24.4	73.1	43.0	0.0	38.12
38	36.9	23.1	65.1	39.4	0.0	52.12
39	38.0	22.2	66.4	31.1	0.0	46.38
40	39.5	22.1	50.9	19.7	0.0	49.19
41	36.4	19.0	61.6	21.6	0.0	42.58
42	35.5	17.3	56.0	22.0	0.0	25.87
43	35.7	16.7	53.1	23.0	0.0	15.89
44	34.0	16.0	58.3	23.7	0.0	3.98

*Standard meteorological weeks

Table 2: Correlations between incidence of whitefly, *B. tabaci* and abiotic factors during *Kharif*, 2018.

Weather parameters	Correlation coefficient (r)
Maximum temperature (°C)	0.104
Minimum temperature (°C)	-0.290
Relative humidity - Morning (%)	-0.506*
Relative humidity - Evening (%)	-0.419
Rainfall (mm)	-0.336

*Significant at 5% level

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