Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
www.entomoljournal.com
JEZS 2020; 8(6): 1636-1641

Received: 29-08-2020
Accepted: 21-10-2020

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Incidence of sucking insect-pests of okra and their correlation with abiotic factors

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Abstract
Investigation on incidence of sucking insect-pests of okra and its relationship with weather parameters was carried out during *Kharif*, 2019 at experimental area, Department of Entomology, CCSHAU, Hisar. Observations for sucking pests were recorded at weekly interval from three leaves per plant, starting from 27th Standard Meteorological Week (SMW). Maximum population of leafhopper (8.8 nymphs/ leaf) and whitefly (3.3 adults/ leaf) was observed during 31st and 32nd SMW, respectively. While the minimum population of leafhopper (0.2 nymphs/ leaf) and whitefly (0.1 adults/ leaf) was recorded during 39th and 27th SMW, respectively. Leafhopper population was significantly and negatively correlated with maximum temperature, while significant and positively correlated with evening relative humidity and rainfall. Correlation of leafhopper with all other weather parameters was negative and non-significant. While considering the whitefly population, it was found significant and positively correlated with rainfall, morning and evening relative humidity; however, a negative and significant correlation existed with maximum temperature. It was concluded that maximum population of sucking insect-pests was recorded during August month and it increases with rainfall.

Keywords: Leafhopper, whitefly, incidence, weather parameters, correlation, okra

Introduction
Okra (*Abelmoschus esculentus)*, also called Ladyfinger/ bhendi, belonging to family *Malvaceae*, is a short duration crop, grown throughout the year. It is an indigenous crop of many countries like South-East Asia, Africa and North Australia to the pacific [5]. In India, it is cultivated over an area of 509 (000'Ha) with production and productivity of 6095 (000' MT) and 12 MT/ha, respectively [3]. Among Indian states, major okra growing states are Andhra Pradesh, Arunachal Pradesh, Assam, Bihar, Chhattisgarh, Gujarat, Haryana and Himachal Pradesh. Haryana is the 7th largest okra producing state with an area of 24.53 (000'Ha), production of 233.96 (000'MT) and productivity of 9.54 MT/ha [3].
Okra crop is devastated by around 72 species of insect-pests and mites throughout its growth period [17]. Among insect pests of okra, the prominent insect pests are leafhopper, *Amrasca biguttula biguttula* (Ishida), whitefly, *Bemisia tabaci* (Gennadius) and okra shoot and fruit borer, *Earias* spp. [23]. The sucking pest complex comprising of whiteflies, leaf hoppers, thrips and mites are major pests and lead to17.46 percent yield loss in okra [22]. Leafhopper, *A. biguttula biguttula* (Ishida) is one of the major sucking pests of okra that feeds mostly on lower surface of okra leaves, ultimately leading to hopper burn [4] causing substantial yield losses upto 40 to 56 percent [18, 11, 7]. Whitefly, *B. tabaci* has become a crucial pest on vegetables, field crops, ornamental plants and fruits all over the world and attacks 176 plant species [20] with ample damage [14]. The pest also transmits the serious disease like yellow vein mosaic, influencing the quality of the produce.
Sucking pest complex has become very profound pest in last few years. Thus, it is now becomes very important to notice the optimal conditions for high population density of these insect pests, so that timely control measures could be taken. For developing weather based pest forecasting system, figures concerning population dynamics of pests in relation to prevalent weather parameters is needed. Abiotic parameters play an essential role to accelerate population of insect pests. To avoid reduction in yield caused by the sucking pests, all efforts are needed to manage these pests by gathering the information of appearing of the pests and influence of various abiotic factors on them. Moreover, correlation study helps in allocating either positive or negative association of pest population abiotic factors.

Thus, in this study the efforts have been made to examine the population dynamics of major sucking pests of okra, and its correlation with abiotic parameters.

Materials and Methods

The field experiment on prevalence of sucking insect-pests on okra, and its correlation with weather parameters was carried out at experimental area, Department of Entomology, CCSHAU, Hisar. The Okra variety "Varsha Uphar" was sown in a plots size of 3 m x 5 m and replicated thrice with keeping row to row and plant to plant distance of 60 x 30 cm. All the advocated agronomic practices including harrowing, weeding, application of fertilizer and irrigation were carried out timely and properly to raise good crop. The crop area kept free from any kind of insecticidal application throughout the season.

Observations recorded

Observations on population of two sucking pests leafhopper, *A. biguttula biguttula* (Ishida) and whitefly, *B. tabaci* (Genn.) were taken at the initiation of the pest from five randomly selected plants. Leafhooper and whitefly were being counted early in the morning at weekly interval on three leaves i.e. upper, middle and bottom canopy of the plant from each randomly selected plants. The average of leafhopper and whitefly population was taken and expressed as number of individuals per leaf. With a view to examine the impact of different weather parameters on pest population, a correlation of pest population with different weather parameters was worked out. The meteorological data on temperature (maximum and minimum), relative humidity (morning and evening), mean bright sunshine hours, wind speed and rainfall in different standard weeks was taken (Table 1) from the Department of Agricultural Meteorology, College of Agriculture, CCS HAU, Hisar, Haryana.

Statistical Analysis: Correlation Co-efficient of whitefly population with different weather parameters and biotic factor was estimated by using OPSTAT software.

Results and Discussion

Leafhopper, *Amrasca biguttula biguttula* (Ishida)

The study was carried out to know the incidence and abundance of leafhooper on "Varsha Uphar" variety of okra during *Kharif*, 2019. The data obtained are summarized in Table 1. The result revealed that the leafhopper incidence noticed from 27th standard meteorological week (1st week of July) at 38.6 ^{0}C maximum, 26.2 ^{0}C minimum temperature and 74.1 and 55.7 percent morning and evening relative humidity, respectively and initially, the population of leafhopper was 0.5 nymphs/leaf. The population was gradually increased and peak population was recorded during 31st SMW (end of July and 1st week of August) with 8.8 leafhopper/ leaf at 33.8 ^{0}C and 25.1 ^{0}C maximum and minimum temperature, respectively and 86.5 and 67.1 percent morning and evening relative humidity and second peak was observed on 33rd SMW (mid of August) with 7.9 leafhopper/ leaf). After second peak the population of leafhoppers declined gradually during the successive weeks, but fluctuated during 36th SMW. While lowest population (0.2 jassid/leaf) was found on 39th SMW (end of September). The population remained below one nymph per leaf during the 27th, 38th and 39th SW and it was significantly higher from 29th to 33rd SMW. However, the leafhopper population remained active till 39th SMW. The present results corroborate with the observations of Sandhi and Sidhu (2018) [21] who reported that jassid nymphal population started appearing in the 24th MSW i.e. 2nd fortnight of June with 0.33 jassid nymphs/ leaf and highest population of 22.42 nymphs/ leaf in the first week of August i.e. 31st MSW. Similar results reported by Potaij *et al.* (2018) [16] who also reported the peak population of leafhopper from the last week of August to September on okra crop. Yadav (2015) [26] reported the infestation of leafhopper stated in the first week of August and reached its peak in the second and third week of September. The results also got support from the findings of [10, 12] who reported that peak leafhopper population on okra in the second and third week of September and then declined gradually. The present findings are not in accordance with Akhila *et al.* (2019) [1] who observed that jassids population was first recorded on the plants of okra, in the 35th standard week, (2.4 jassids per plant) and peak infestation was observed during 1st week of October in the 40th standard week. Anitha and Nandihalli (2008) [2] also noticed 4.33 jassid per 3 leaves from first week of April and peak jassid incidence (18.44 jassid /3 leaves) was noticed by them during the last week of June. The slight variation in commencement of incidence and peak period of incidence may probably be due to the difference in agro-climatic conditions of the locality.

The leafhopper population had a significant and negative correlation (r = -0.610*) with maximum temperature, while minimum temperature showed non-significant negative correlation with leaf hoppers (r= -0.177). Evening relative humidity showed highly significant and positive correlation with leafhopper population (r = 0.869**), whereas morning relative humidity showed positive but non-significant correlation (r = 0.545) with leafhopper population. Average wind speed (r = -0.109) and bright sunshine hours (r = -0.350) showed negative and non-significant correlation, whereas, rainfall had positive and significant correlation with leafhopper population (r = 0.581*) (Table 2, Fig. 1 and 2). The present findings are in accordance with Nagar *et al.* (2017a) [12] who reported that population of leafhopper showed negative correlation with maximum temperature and positive significant correlation with relative. Similarly, Sandhi and Sidhu (2018) [21] reported that jassid nymphal population had a significant and negative correlation with the maximum temperature and significant and positive correlation was found between jassid nymphal population and morning humidity (r = 0.68) and evening humidity (r = 0.74). The sunshine hours were found to be significant and negatively correlated (r = 0.53) with the nymphal population. Our results are in line with the findings of Akhila *et al.* (2019) [1] that jassids incidence was positively correlated with maximum and minimum relative humidity during the study period. Similarly, [6, 13] in brinjal and *Bt* cotton, respectively, reported the positive correlation of jassid population with the relative humidity as the humid season is quite conducive for population build-up of this pest. Pandey and Koshta (2017) [15] also reported the positive correlation of evening relative humidity with jassid population. Rainfall has shown positive influence on the population buildup of jassids reported by [1], [13] also found the positive correlation of leafhopper population with the rainfall in cotton. However, [15, 9] observed a negative and non-significant correlation of jassid nymphal population with the rainfall. The results are not in conformity with Jat and Singh (2019) [8] who reported that leaf hopper population had positive significant correlation with maximum and minimum temperature. Similarly, Akhila *et al.* (2019) [1]

reported both the maximum temperature and minimum temperature were positively correlated with the population buildup of jassids. Rehman *et al.* (2016) [19] also reported that leafhopper population had significant positive correlation with minimum temperature.

Whitefly, *Bemisia tabaci* (Gennadius)

The results presented in Table 1 and Figure 3 and 4 revealed that the population of whitefly was ranging from 0.1 to 3.3 whitefly per leaf during *Kharif*, 2019. The whitefly incidence was started from 27th SMW (1st week of July) at 38.6 ^{0}C maximum, 26.2 ^{0}C minimum temperature and 74.1 and 55.7 percent morning and evening relative humidity, respectively.

During the experiment, the population of this pest showed peak on okra crop. The peak (3.3 whitefly/leaf) was observed at 32nd SMW (2nd week of August) at 34.6 ^{0}C maximum, 27.0 ^{0}C minimum temperature and 86.5 and 67.7 percent morning and evening relative humidity, respectively. After the peak point, the population declined gradually during the successive weeks, with slight fluctuations in 34th SMW (last of August). The present findings are in partial akin with the observations of Khating *et al*. (2016) [10] who reported that incidence of whitefly on okra started in last week of July and reached its peak in 2nd week of September. Similarly, Yadav (2015) [26] also reported that incidence of whitefly on okra infestation of whitefly commenced in the first week of August and reached its peak in the second and third week of September. The slight difference in the incidence might be attributed due to the difference in sowing date of the crop and climatic factors of the region.

Study on effect of various weather parameters on the alteration of whitefly population on okra during *Kharif*, 2019 (Table 3) indicated that maximum temperature was significantly negative correlated (r= -0.566), while minimum temperature showed non-significant and negative correlation (r= -0.105). Morning and evening relative humidity were found to have a significantly positive correlation with whitefly population (r= 0.658 and 0.643 respectively). Correlation of whiteflies with rainfall was also noted to be positive and significant (r=0.566), while, with bright sunshine hours it was non-significant and positive (r= 0.149). The correlation between whitefly population and average wind speed was non-significant and negative (r= -0.353). The present findings are in line with Singh *et al*., (2013) [24] who reported that the whitefly population responded negatively with maximum, minimum and mean temperature and maximum and minimum relative humidity showed positive correlation. However, Jat and Singh (2019) [8] showed that whitefly population exhibited positive significant correlation with maximum and minimum temperature while had negative significant correlation with rainfall. Similarly, Yadav (2015) [26] reported that incidence of whitefly population exhibited positive significant correlation with minimum temperature and had negative significant correlation with rainfall. Solanki (2005) [25] examined that whitefly population had significant positive correlation with maximum temperature and significant negative correlation with minimum temperature as well as morning relative humidity. These findings are not in conformity of present findings.

Table 1: Incidence of leaf hopper and whitefly on okra during various standard meteorological weeks with meteorological data of *Kharif*, 2019

SMW	Average leafhopper Population (nymphs/ leaf)	Average whitefly Population (adults/leaf)	Temperature (°C)		Relative Humidity		Average Wind Speed (KM/H)	Bright Sun Shine Hours	Rainfall (mm)
			MAX	MIN	M	E			
27	0.5	0.1	**38.6**	26.2	74.1	55.7	6.5	6.5	1.8
28	3.2	0.3	37.2	27.3	72.7	56.6	9.9	0.7	13.4
29	6.6	1.9	32.5	23.7	93.1	70	6.2	4.5	81.5
30	7.6	1.5	33.2	25.3	88.3	72.6	6.4	3.8	23.7
31	8.8	2.7	33.8	25.1	86.5	67.1	5.6	5.3	17.7
32	7.4	3.3	34.6	27	86.5	67.7	7.2	6.3	63
33	7.9	2.1	33.3	25.5	89.3	70.2	5.7	4.5	15.4
34	4.2	2.2	35.6	25.8	86.2	55.9	4.7	8.2	0
35	2.9	1.2	36.2	27.4	83.5	54.8	5.2	6.9	0
36	3.7	1.9	35.7	27	89	59	4.1	6.2	27.7
37	2.2	0.8	37	27.1	87.5	51.2	5.1	6.6	0
38	0.9	0.5	35.1	25.2	84.2	49.4	6.8	6.7	0
39	0.2	0.9	33.4	24.3	83.6	57.6	6.9	7.2	2.2

Table 2: Correlation of weather parameters with sucking pests of Okra during *Kharif*, 2019

Okra sucking pests	Temperature (°C)		Relative Humidity		Average Wind Speed (KM/H)	Bright Sun Shine Hours	Rainfall (mm)
	MAX	MIN	M	E			
Leaf hopper	-0.610*	-0.177NS	0.545NS	0.869**	-0.109NS	-0.350NS	0.581*
Whitefly	-0.566*	-0.105NS	0.658*	0.643*	-0.353NS	0.149NS	0.566*

* Indicate significant at p=0.05 **Indicate significant at p=0.01

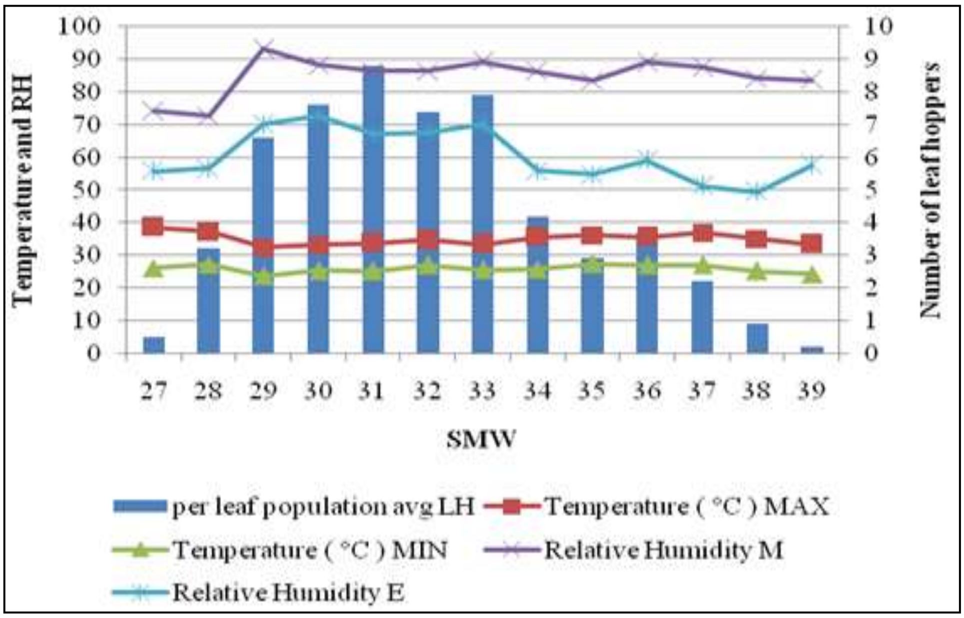

Fig 1: Correlation of temperature and RH with leaf hopper population

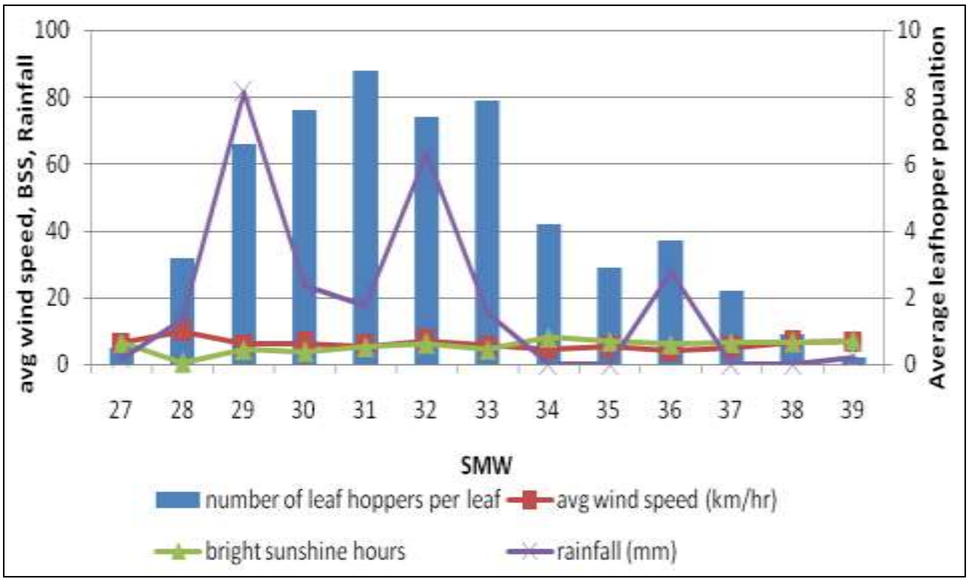

Fig 2: Correlation of average wind speed, bright sunshine hours and rainfall with leaf hopper population

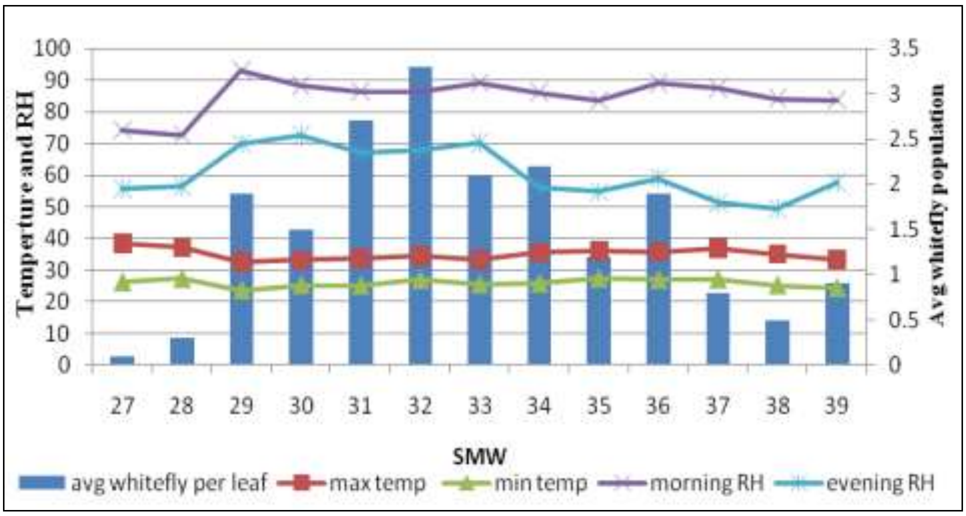

Fig 3: Correlation of temperature and RH with whitefly population

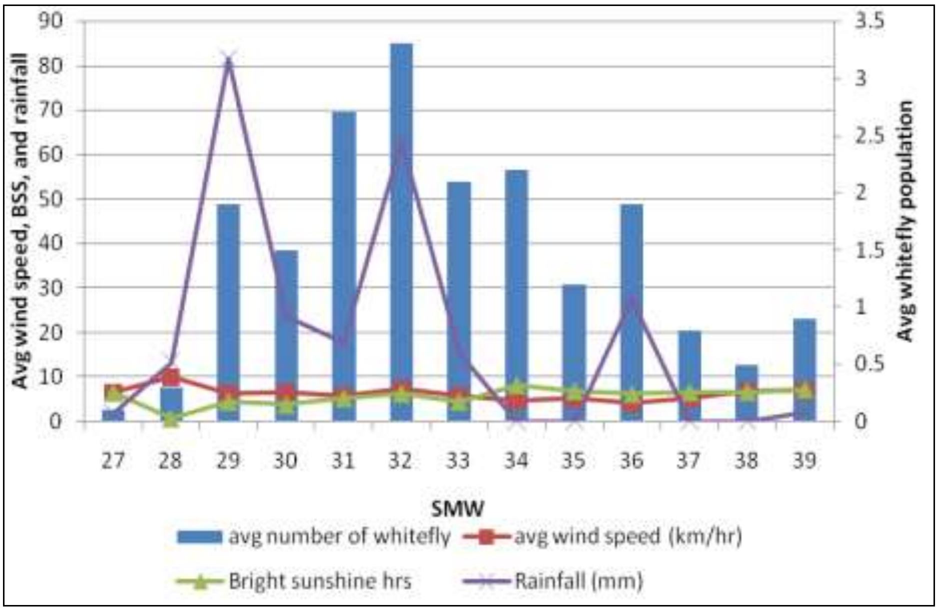

Fig 4: Correlation of average wind speed, bright sunshine hours and rainfall with whitefly population

Conclusion
From the present study, we can conclude that the maximum population of sucking insect-pests was recorded during the month of August and it increased with increase in rainfall. Leafhopper population increased with decrease in maximum temperature, but it was found to be directly/ positively correlated with change in evening relative humidity and rainfall. While, whitefly population was found significantly positive correlated with rainfall, morning and evening relative humidity; but, a significantly negative correlation existed with maximum temperature.

Acknowledgement
Author thankful to to the head, Department of Entomology, College of Agriculture, CCS Haryana Agricultural University, Hisar; for providing all the necessary facilities for the research work.

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