Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

JEZS Journal of Entomology and Zoology Studies

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2020; 8(1): 540-545

Received: 24-11-2019
Accepted: 28-12-2019

Nistha Rawat
Ph.D. Scholar, Department of Entomology, Govind Ballabh Pant University of Agriculture & Technology, Pantnagar, Uttarakhand, India

AK Karnatak
Professor, Department of Entomology, Govind Ballabh Pant University of Agriculture & Technology, Pantnagar, Uttarakhand, India

RM Srivastava
Professor, Department of Entomology, Govind Ballabh Pant University of Agriculture & Technology, Pantnagar, Uttarakhand, India

Corresponding Author:
Nistha Rawat
Ph.D. Scholar, Department of Entomology, Govind Ballabh Pant University of Agriculture & Technology, Pantnagar, Uttarakhand, India

Population dynamics of major sucking insect pests of Okra in agro-climatic condition of Pantnagar

Nistha Rawat, AK Karnatak and RM Srivastava

Abstract

The present investigation was carried out to study the population dynamics of important sucking insect's pest of Okra *viz*., aphid, white fly and leaf hoppers and influence of various weather parameters on them at Vegetable research centre, Gobind Ballabh Pant University of Agriculture & Technology, Pantnagar, Uttarakhand, during 2016-2017. The incidence of aphid was recorded at 29th SMW (standard meteorological week) to 39 SMW, while whitefly at 30th to 39 SMW and hoppers at 30th to 39th SMW. The result revealed that peak incidence of aphid population was observed 29.70 aphids/3 leaves in 36th standard week followed by whitefly 12.13 whitefly/ 3 leaves in 37th SMW and leaves hoppers 11.13 hoppers/ 3 leaves. Correlation of aphid population with weather parameters shown non-significant positive correlation with maximum and minimum temperature(r = 0.527 and r = 0.096, respectively), wind velocity(r = 0.291) and relative humidity of morning (r = 0.149). However, rainfall (r = -0.612) and sun-shine hours (r = -0.309) indicated significant negative correlation while relative-humidity of evening (r = -0.397) showing non-significant negative correlation. In white fly there was non-significant positive correlation with maximum temperature (r = 0.460), wind velocity(r = 0.494) and relative humidity of morning (r = 0.117). Relative-humidity of evening (r = -0.624), rainfall (r = -0.655) and sun-shine hours (r = -0.625) showing significant negative correlation, but minimum temperature showing non-significant negative correlation. Hopper population correlated with weathers parameters indicated that there was non-significant positive correlation with maximum temperature (r = 0.513), relative humidity of morning (r = 0.153) and wind velocity (r =0.530) but have significant negative correlation with rainfall (r = -0.602) and sun-shine hours (r = -0.630) also non-significant negative correlation with minimum temperature (r = -0.291) and relative humidity of evening (r = -0.682*), respectively. The linear regression analysis using weather parameters as independent variables and aphid, white fly and hoppers as dependent variables could explain the variability up to 78% (R^2= 0.78), 80% (R^2 = 0.80) and 77% (R^2 = 0.77), respectively.

Keywords: okra, aphid, hoppers, white fly, population

Introduction

Okra *Abelmoschus esculentus* L. (Moench) is the second largest cultivated crop, a potential export earner and accounting for about 60 per cent of export of the total fresh vegetables (Peirce, 1987) [13]. India is the second largest producer of vegetables in the world after China, while it ranks first in Okra production which is 61.90% of the total global production followed by Nigeria (22.2% of the total global production). In India, production was about 6073 thousand MT from 506 thousand ha of area during 2017-2018 (Anonymous, 2018) [1]. Okra is known by many local names in different parts of the world. It is called Lady's finger in England, Gumbo in the United States of America and Bhindi in India. *A. esculentus* (Okra) is cultivated throughout the tropical and warm temperate regions of the world for its fibrous fruits or pods containing round, white seeds. It is the most heat and drought-tolerant vegetable species present in the world and can even tolerate soils with heavy clay and intermittent moisture, but susceptible to frost as it can damage the pods. This crop is affected by several biotic, physiochemical and meso-biotic factors. Among the biotic factors insect-pests are predominant and occur regularly at different stages of crop growth. Among other various factors responsible for lower yield of Okra, insect pests *viz*., the fruit borer, *Helicoverpa armigera* (Hubner), Okra shoot and fruit borer, *Earias vittella* (Fabricius) and sucking insect pests *viz*., whitefly *Bemesia tabaci* (Gennadius)., Jassids, *Amrasca biguttulla* (Ishida) and thrips *Thrips tabaci* (Lind) are highly destructive causing serious damage and are responsible for lowering the yield of Okra crop (Lal *et al*., 1990) [10]. Among these insects pest sucking

Pest have their own potential importance not only they feed on Okra crop but also they are vectors for many viral diseases**.** The whitefly *B. tabaci* is an important pest of okra plant (Butter *et al.*, 1978) [5] infesting wide range of crops. The wide range of geographical distribution with variety of host range makes it difficult to control the whitefly. *B. tabaci,* sucks the phloem sap of growing okra plants and also transmits yellow vein mosaic virus (YVMV) disease in Okra. Such direct feeding induces plant physiological disorders, which results in early shedding of immature fruit-parts (Yokomi *et al.*, 1998; Bharathan *et al.*, 1990) [23, 5]. Both adult and immature stages of this insect cause direct damage through sucking the plant sap (Brown *et al.*, 1995) [4] and causes insurmountable losses to Okra plants .*Amrasca biguttula biguttula* and Aphids (*A. gossypii*) are the other two major and regular pests of okra crop in Tarai region of Uttarakhand.
In the light of above facts this experiment was carried out to determination of population dynamics of sucking insect pests of okra and impact of weathers parameters on them.

Materials and Methods

Experimental site

The field experiments were carried out to perceive the population dynamics and correlation of weather parameter with major sucking insect pests of Okra crop (variety Parbhani Kranti) at Vegetable Research centre (VRC), G. B. Pant University of Agriculture and Technology, Pantnagar Udham Singh Nagar (Uttarakhand) during *kharif* crop season 2017. Observations on population of pests were recorded after 15 days of sowing (15 DAS) at weekly interval up to harvesting. These observations of number of insects were taken on three leaves per plant, one each from top, middle and bottom region from five randomly selected plants per plot selected leaving border rows. The mean weekly weather data during crop season was collected from meteorological observatory, N.E. Borlaug Crop Research Centre, Pantnagar.

Observation on population dynamics of major sucking pests of Okra

1. Whitefly, *Bemisia tabaci (Gennadius*)

Whitefly, *B. tabaci* population was documented after 15 days of sowing (15 DAS) at weekly interval up to harvesting. These observations were taken on three leaves per plant, one each from top, middle and bottom region from five randomly selected plants per plot selected leaving border rows.

2. Leaf hopper, *A. biguttula bigutulla* (Ishida)

Population of nymphs and adults of the leaf hopper, *A. biguttula bigutulla* on Okra crop was recorded after 15 days of sowing (15 DAS), at weekly interval through proper monitoring. These observations were taken on three leaves per plant, one each from top, middle and bottom region from five randomly selected plants per plot leaving border rows.

3. Aphid, *A. gossypii* (Glover)

Population of nymphs and adults of the aphid, *A. gossypii* (Glover) was also recorded on Okra crop after 15 days of sowing (15 DAS) at weekly interval. These observations were also taken on three leaves per plant, one each from top, middle and bottom region from five randomly selected plants per plot leaving border rows.

Results and Discussion

Population dynamics of major sucking insect-pests of okra during *kharif,* 2017

1. Leaf hopper, *A. biguttula*

In *kharif*, 2017, incidence of the leaf hoppers recorded from 30th standard metrological week to 39th standard metrological week (last week of September) (Table 1.). The first appearance of this pest was marked by an average of 0.83 leaf hopper/3 leaf in 30th standard metrological week when the maximum temperature, minimum temperature, morning relative humidity, evening relative humidity (RH), rainfall, sunshine, wind velocity were 30.8 ^{0}C, 24.9 ^{0}C, 89% (07:12 am), 76% (14:12 pm), 125.9 mm, 06.5 hrs, 3.9km/hr, respectively. The population gradually increased and attained maximum (11.13 hopper/3 leaves) in the 37th standard metrological week (SMW) when the maximum-minimum temperature, morning-evening relative humidity (RH), rainfall, sunshine hr, wind velocity were 32.1^{0}C, 24.5^{0}C, 89% (07: 12 am), 71% (14: 12 pm), 059.4 mm, 04.3hrs, 4.5 km/hr, respectively followed by gradual decrease in population till 39th standard metrological week (SMW) this observation is somehow similar to Yadav *et al.* (2008) [22] who reported peak population of pest in 36th standard metrological week and *Amrasca biguttula biguttula* incidence from 32nd standard metrological week to 41th standard metrological week. Sharma *et al.* (1997) [18] who reported the activity of *Amrasca biguttula biguttula* from July to till harvesting of Okra and peak population observed in first week of August.

Table 1: Fluctuation in population of leaf hopper in relation to weather parameters at VRC, Pantnagar, during *kharif*, 2017

Month	Date	SMW	Temperature (^{0}C)		Relative Humidity (%)		Rainfall (mm)	Sun- Shine (Hrs.)	Wind Velocity (Km/hr)	leaf hoppers population/ 3 leaves
			Maximum	Minimum	07:12 AM	14:12 PM				
July	09-15	28	33.0	26.2	89	72	052.6	05.6	4.2	0.00
July	16-22	29	32.0	25.5	91	76	119.2	05.9	2.8	0.00
July	23-29	30	30.8	24.9	89	76	125.9	06.5	3.9	0.83
July-Aug.	30-05	31	31.7	25.7	86	69	150.8	07.1	5.5	1.80
Aug.	06-12	32	33.0	26.3	89	70	040.2	06.8	5.7	5.90
Aug.	13-19	33	32.9	25.9	93	69	100.6	03.9	4.7	8.89
Aug.	20-26	34	33.1	26.3	87	67	002.4	04.7	7.8	8.95
Aug.-Sept.	27-02	35	34.0	25.5	89	65	026.6	03.8	5.5	9.52
Sept.	03-09	36	32.7	25.3	91	68	002.4	06.2	6.2	10.01
Sept.	10-16	37	32.1	24.5	89	71	059.4	04.3	4.5	11.13
Sept.	17-23	38	32.7	24.2	90	66	076.6	03.6	5.9	9.95
Sept.	24-30	39	32.6	23.2	87	62	003.4	02.9	8.9	7.79
Correlation			0.513^{NS}	-0.291	0.153	-0.682*	-0.602*	-0.630*	0.530	-
R^2 (Regression Coefficient)			0.77							

* Significant at 0.01 level; ** Significant at 0.05 level; Max- Maximum temperature; Min.- Minimum temperature

Regression equation

$Y = 348.83 – 1.33 X_1 + 4.35 X_2 + 0.65 X_3 -2.46 X_4 – 0.10 X_5 – 1.62 X_6 -3.71 X_7$.

Where,
X_1 = Maximum Temperature, X_2 = Minimum Temperature, X_3 = Relative Humidity (Morning), X_4 = Relative Humidity (Evening), X_5 = Rainfall, X_6 = Sun-Shine Hours, X_7 = Wind velocity.

2. Whitefly, *B. tabaci*

In *kharif*, 2017, incidence of *Bemisia tabaci* observed from 30th standard metrological week to 39th standard metrological week (Table 2). The first arrival of this pest was marked by an average of (0.01whitefly/3 leaves) in 30th standard metrological week when the maximum-minimum temperature, morning-evening relative humidity (RH), rainfall, sunshine hrs, wind velocity were 30.8 ^{0}C, 24.9 ^{0}C, 89%(0712am), 76%(1412pm),125.9 mm, 06.5hrs, 3.9km/hr respectively. After its first arrival in 30th SMW the population of *Bemisia tabaci* gradually increased and attained maximum (12.13 whitefly/3 leave) in the 37thstandard metrological week (SMW) when the maximum-minimum temperature, morning-evening relative humidity (RH), rainfall, sunshine hrs, wind velocity were 32.1^{0}C, 24.5^{0}C, 89% (0712am), 71%(1412pm), 059.4 mm, 04.3hrs, 4.5km/hr respectively followed by gradual decrease in population till 39thstandard metrological week (SMW). Thus, these climatic conditions appeared to be most favourable for the increased growth of population and activity of this pest in the present study. The result of present study are in accordance with finding of Selvaraj *et al.* (2010) [17] recorded the peak incidence of whitefly from mid-August to mid-October. Kumawat *et al.*, (2000) [9] also reported that the whitefly first appearance seen in 4th week of July (30th standard metrological week) also it attained its peak population in month of September on okra crop. However, Board *et al.* (1993) [3] on two years study noticed peak activity and population of whitefly during the first week of October. The difference in the activity of the pest may be due to variation in ecological factors.

3. Aphids, *A. gossypii*

In *kharif*, 2017, incidence of *A. gossypii* was noticed from 29th standard metrological week (SMW) to 39th standard metrological week (Table 3.). The first appearance of this pest was recorded with an average of 0.01aphids/ 3 leaves in 29th standard metrological week when the maximum temperature, minimum temperature, morning relative humidity, evening relative humidity (RH), rainfall, sunshine, wind velocity were 32.0 ^{0}C, 25.5 ^{0}C, 91% (07:12AM), 76% (14:12PM), 119.2 mm, 05.9 hrs, 2.8 km/hr respectively. The population gradually increased and attained maximum (29.7 aphids/ 3 leaves) in the 36th standard metrological week (SMW) when the maximum-minimum temperature, morning-evening relative humidity (RH), rainfall, sunshine hrs, wind velocity were 32.7 ^{0}C, 25.3 ^{0}C, 91%(0712am), 68%(1412pm),002.4 mm, 06.2hrs, 6.2km/hr respectively followed by gradual decrease in population till 39thstandard metrological week (SMW).

These findings are supported by Konar *et al.* (2013) [8] who reported the appearance of aphid on okra at West-Bengal during second week of July (0.74aphids/3 leave) on 29th standard metrological week (SMW) and marked decline in population (7.45 aphids/3 leave) in 29th standard metrological week (SMW). Siddartha *et al.* (2017) [20] reported thatduring *kharif 2015*, the incidence of aphids commenced from second week of July (28thstandard metrological week), which rapidly increased and attained its peak on 31st SMW (last week of July) with a mean population density of 6.20 aphids per leaf.

Table 2: Fluctuation in population of whitefly in relation to weather parameters at VRC, Pantnagar, during *kharif*, 2017

Month	Date	SMW	Temperature (^{0}C)		Relative Humidity (%)		Rainfall (mm)	Sun- Shine (Hrs.)	WindVelocity (Km/hr)	Whitefly population/3 leaves
			Maximum	Minimum	07:12AM	14:12 PM				
July	09-15	28	33.0	26.2	89	72	052.6	05.6	4.2	0.00
July	16-22	29	32.0	25.5	91	76	119.2	05.9	2.8	0.00
July	23-29	30	30.8	24.9	89	76	125.9	06.5	3.9	0.01
July-Aug.	30-05	31	31.7	25.7	86	69	150.8	07.1	5.5	0.01
Aug.	06-12	32	33.0	26.3	89	70	040.2	06.8	5.7	3.12
Aug.	13-19	33	32.9	25.9	93	69	100.6	03.9	4.7	5.91
Aug.	20-26	34	33.1	26.3	87	67	002.4	04.7	7.8	8.75
Aug.-Sept.	27-02	35	34.0	25.5	89	65	026.6	03.8	5.5	9.05
Sept.	03-09	36	32.7	25.3	91	68	002.4	06.2	6.2	11.05
Sept.	10-16	37	32.1	24.5	89	71	059.4	04.3	4.5	12.13
Sept.	17-23	38	32.7	24.2	90	66	076.6	03.6	5.9	9.59
Sept.	24-30	39	32.6	23.2	87	62	003.4	02.9	8.9	7.41
Correlation Whitefly population			0.460	-0.368	0.117	-0.624*	-0.655*	-0.625*	0.494	-
R^2 (Regression Coefficient)			0.80							

* Significant at 0.01 level; ** Significant at 0.05 level; Max- Maximum temperature; Min.- Minimum temperature

Regression equation

$Y = 486.15 - 11.86 X_1 + 4.61 X_2 + 0.38 X_3 - 2.87 X_4 - 0.14 X_5 - 1.93 X_6 - 5.35 X_7$

Where,
X_1 = Maximum Temperature, X_2 = Minimum Temperature, X_3 = Relative Humidity Morning, X_4 = Relative Humidity Evening, X_5 = Rainfall, X_6 = Sun-Shine Hours, X_7 = Wind velocity

2. Correlation between population dynamics of insect pest of okra with weather parameters (2017)

1. Correlation of weather parameters with leaf hopper, *A. biguttula*

Simple correlation worked out between the weather parameters and the population of *A. biguttula biguttula* (Table 1.) revealed that there was non-significant positive correlation with maximum temperature (0.513), relative humidity of morning (0.153) and wind velocity (0.530) but have significant negative correlation with rainfall (r = -0.602) and sun-shine hours (r = -0.630) also non-significant negative correlation with minimum temperature and relative humidity of evening respectively. This means as we increase the maximum temperature, relative humidity of morning and wind velocity it will also increase the population of *A. biguttula biguttula* (leaf hopper) while with increase in rainfall, sun-shine hours, minimum temperature and relative humidity of evening the leaf hopper, *A. biguttula biguttula* population decreased. Our results were similar to the finding of Soni and Dhakad (2016) [21] for population buildup of jassid *(A. biguttula biguttula)*, maximum temperature recorded non-significant positive correlation. Rainfall (r= -0.638) showed highly significant negative correlation in first year while non-significant negative correlation in next year. Minimum temperature, evening humidity and wind velocity were non-significant negatively correlated with jassid population in both the years. The present findings have also agreement with Saroj *et al.* (2017) [16] where Jassids population showed non-significant positive correlation with maximum temperature (r= 0.371), relative humidity (0.071) and negative correlation with rainfall. Yadav *et al.* (2008) [22] observed that maximum temperature, minimum temperature had a significant positive correlation between jassids population while minimum and maximum relative humidity and rainfall had negative correlation with this pest population. This finding is again supported by Men *et al.* (1996) [12] who found a significant positive correlation between maximum temperature and *A. biguttula biguttula* (jassid) population. Nath *et al.* (2011) [13] studied that there was non-significant positive correlation of maximum and minimum temperature, rainfall and sunshine hours but non-significant negative correlation of relative humidity with pest population.

Following regression equation was developed to predict the incidence of hoppers.

$$Y\ (\text{hoppers}) = 348.83 - 1.33\ X_1 + 4.35\ X_2 + 0.65\ X_3 - 2.46\ X_4 - 0.10\ X_5 - 1.62\ X_6 - 3.71\ X_7$$

The regression equation revealed that the various abiotic factors were found to be most influencing factors which contributed R^2= 0.77 (77%) variation in hopper (*A. biguttula biguttula)* population.

The regression equation was fitted to the study the effectiveness of weather parameters indicated that for every 1^0c decrease in maximum temperature 1.33 number of hopper increased while increase in 1^0c in minimum temperature 4.35 number of hoppers increased. While 1^0C increase in morning relative humidity 0.24 number of hoppers increased. Whereas, 1^0C decrease in evening relative humidity, rainfall, sunshine hours and wind velocity decrease in 2.46, 0.10, 1.62 and 3.71 number of hoppers, respectively.

2. Correlation of weather parameters with Whitefly, *B. tabaci* Gennadius

Simple correlation worked out between the weather parameters and the population of Whitefly, (*B. tabaci*) revealed that there was non-significant positive correlation with maximum temperature (r = 0.460), wind velocity (r = 0.494) and relative humidity of morning (r = 0.117). However, relative-humidity of evening (-0.624), rainfall (r = -0.655) and sun-shine hours (r = -0.625) showing significant negative correlation also minimum temperature showing non-significant negative correlation. These findings were partially supported by Shaito *et al.* (2012) [15] who observed that there non-significant negative correlation between whitefly population and temperature and highly significant negative correlation with relative-humidity. The seasonal incidence of whitefly on okra reported by Kumawat *et al.* (2000) [9] also revealed that maximum temperature exhibited a significant correlation with whitefly density. Likewise, Deepesh *et al.* (1997) [6] observed the population of *B. tabaci* showed a significant positive association with temperature. Meena *et al.* (2009) [11] found that maximum and minimum temperature, rainfall and relative-humidity had non-significant correlation with the whitefly population. These differences may be due to different ecological conditions in different localities.The findings of Selvaraj *et al*. (2010) [17] and Nath *et al.* (2011) [13] somehow, supported the present findings, who also reported positive correlation with maximum and minimum temperature and non-significant negative correlation with relative humidity and rainfall.

Following regression equation was developed to predict the incidence of whitefly.

$$Y\ (\text{whitefly}) = 486.15 - 11.86\ X_1 + 4.61\ X_2 + 0.38\ X_3 - 2.87\ X_4 - 0.14\ X_5 - 1.93\ X_6 - 5.35\ X_7$$

The regression equation revealed that the various abiotic factors were found to be most influencing factors which contributed R^2= 0.80 (80%) variation in of whitefly (*B. tabaci*) population.

The regression equation was fitted to the study the effectiveness of weather parameters indicated that for every 1^0C increase in maximum temperature 11.86 number of whitefly (*B. tabaci*) decrease while increase in 1^0C in minimum temperature 4.61 number of whitefly increased. While 1^0C increase in morning relative humidity 0.38 number of whitefly increased. Whereas, 1^0C decrease in evening relative humidity, rainfall, sunshine hours and wind velocity decrease in 2.87, 0.14, 1.93 and 5.35 number of whitefly, respectively.

3. Correlation of weather parameters withAphids (*A. gossypii*).

Simple correlation worked out between the weather parameters and the population of aphid as presented in Table 3. It indicates that there was non-significant positive correlation with maximum and minimum temperature (r = 0.527 and r = 0.096), wind velocity (r = 0.291) andrelative humidity of morning (r = 0.149). However, rainfall (r = -0.612) and sun-shine hours (r = -0.309) showing significant negative correlation also relative-humidity of evening (-0.397) showing non-significant negative correlation. This study indicating that pest population increased with increasing temperature (maximum and minimum) and wind velocity, but decreased with increasing rainfall, sun-shine hours and relative-humidity of evening. Our studies were similar to Siddhartha (2017) [20] who reported that maximum temperature showed significant positive correlation with population of aphids (*A. gossypii*) during *Rabi* 2014. Maximum temperature and average temperature had significant positive effect on leaf hoppers, aphids and whiteflies but negative on mites. Morning and evening relative humidity had not influence much on the population of sucking pests, whereas rainfall had significant effect on the sucking pest population in contradictory Konar *et al.* (2013) [8] state that aphid population shows non-significant negative correlation with temperature (minimum and maximum), minimum relative humidity, rainfall and total sunshine hours. Jadhav *et a*l. (2013) [7] also reported that aphid showed negatively significant correlation with rainy days which were similar to our study. Shivanna *et al*. (2011) [19] revealed that less temperature showed negative effect on aphid population mean temperature has positive correlation with population of aphids (*A. gossypii*).

Following regression equation was developed to predict the incidence of aphid:

Y Aphid= $1601.77 - 41.36X_1 + 22.23X_2 + 0.31 X_3 - 1.71 X_4 - 0.51 X_5 - 5.65 X_6 - 19.74X_7$

The regression coefficient revealed that the various abiotic factors were found to be most influencing factors which contributed $R^2 = 0.78$ (78%) variation in aphid population. The regression equation was fitted to the study the effectiveness of weather parameters indicated that for every 1 ^{0}C increase in maximum temperature 41.36 number of aphids will be decreased while increase in 1 ^{0}C in minimum temperature 22.23 number of aphids increased. While 1 ^{0}C increase in morning relative humidity 0.31 number of aphids increased. Whereas, 1 ^{0}C increase in evening relative humidity, rainfall, sunshine hours and wind velocity decrease in 1.71, 0.51, 5.65 and 19.74 number of aphids, respectively.

Table 3: Fluctuation in population of aphid in relation to weather parameters at VRC, Pantnagar, during *kharif*, 2017

Month	Date	SMW	Temperature (^{0}C)		Relative Humidity (%)		Rainfall (mm)	Sun-Shine (Hrs.)	Wind Velocity (Km/hr.)	Aphid population/ 3 leaves
			Maximum	Minimum	07:12AM	14:12 PM				
July	09-15	28	33.0	26.2	89	72	052.6	05.6	4.2	0.00
July	16-22	29	32.0	25.5	91	76	119.2	05.9	2.8	0.01
July	23-29	30	30.8	24.9	89	76	125.9	06.5	3.9	0.01
July-Aug.	30-05	31	31.7	25.7	86	69	150.8	07.1	5.5	0.92
Aug.	06-12	32	33.0	26.3	89	70	040.2	06.8	5.7	8.03
Aug.	13-19	33	32.9	25.9	93	69	100.6	03.9	4.7	14.50
Aug.	20-26	34	33.1	26.3	87	67	002.4	04.7	7.8	25.55
Aug.-Sept.	27-02	35	34.0	25.5	89	65	026.6	03.8	5.5	28.50
Sept.	03-09	36	32.7	25.3	91	68	002.4	06.2	6.2	29.70
Sept.	10-16	37	32.1	24.5	89	71	059.4	04.3	4.5	26.03
Sept.	17-23	38	32.7	24.2	90	66	076.6	03.6	5.9	7.35
Sept.	24-30	39	32.6	23.2	87	62	003.4	02.9	8.9	4.03
Correlation			0.527	0.096	0.149	-0.397	-.612*	-0.309*	0.291	
R^2 (Regression Coefficient)			0.78							

* Significant at 0.01 level; ** Significant at 0.05 level; Max- Maximum temperature; Min. - Minimum temperature

Regression Equation

$$Y= 1601.77 - 41.36X_1 + 22.23X_2 + 0.31 X_3 - 1.71 X_4 - 0.51 X_5 - 5.65 X_6 - 19.74X_7$$

Where,

X_1 = Maximum Temperature, X_2 = Minimum Temperature, X_3 = Relative Humidity Morning, X_4 = Relative Humidity Evening, X_5= Rainfall, X_6= Sun-Shine Hours, X_7= Wind velocity.

Conclusion

Okra is one of the second largest cultivated crop in India**.** This important crop is infested by various sucking insects pests *viz*., whitefly *B. tabaci;* Jassids, *A. biguttulla biguttula* (Ishida) and thrips *T. tabaci* and cause severe damage resulting in lowering the yield of crop. These insect pests are having potential to spread several types of virus in plants as whitefly spread yellow vein mosaic virus (YVMV) disease. It has been observed that sucking insects pests as leaf hoppers, white fly and aphids population appeared in 3rd week of July (30.8 ^{0}C and 89% RH), 1st week of August (33.0 ^{0}C and 89% RH) and 3rd week of July (31.7 ^{0}C and 86% RH), respectively, while highest population was recorded in 2nd week of September (32.1 ^{0}C and 89% RH) while 2nd week of September (32.1 ^{0}C and 89% RH) and 1st week of September (32.7 ^{0}C and 91% RH). In case of hoppers temperature and relative humidity were non-significant positive correlated with insect population but rainfall and sunshine had negative-significant effect on hoppers population. While, white fly was positively non-significant correlated and negative- correlated with sunshine and rainfall. Whereas, aphid population was negative correlated with rainfall, sunshine and evening relative humidity. Variations in insect population *viz*., hoppers, white fly and aphids recorded 77% ($R^2 = 0.77$), 78% ($R^2 = 0.80$) and 78% ($R^2 = 0.78$). Hence it can be concluded that insects population were greatly influenced by weather parameters.

References

1. Anonymous. Ministry of Agriculture, Government of India, Indian Horticulture Database, 2018.
2. Bharathan N, Graves WR, Narayanan KR, Schuster DJ, Bryan HH, McMillan RT. Association of double stranded RNA with whitefly-mediated silvering in squash. Plant Pathology. 1990; 39:530-538.
3. Board VK, Puri SN, Brown JK, Butle GD. Relationship of *Bemisia tabaci* population density and yellow vein mosaic disease incidence in okra. Pest management and economic zoology. 1993; 1(1):14-19.
4. Brown JK, Frohlich D, Rosell R.C. The sweet potato or silver leaf whiteflies: biotypes of *Bemisia tabaci* or a species complex. Annual Review of Entomology. 1995; 40:511-534.
5. Butter NS, Rataul HS. Science and Culture. 1978; 44:168-170.
6. Deepesh S, Bagmare A, Gupta A. Effect of weather parameter on population build-up of key pests of soyabean. Journal of Insect Science. 1997; 10(2):120-124.
7. Jadhav DS, Shukla A. Relative toxicity of some insecticides to *Coccinella transversalis* (F.). Indian Journal of Entomology. 2013; 75(4):301-303.
8. Konar A, More KA, Ray SKD. Population dynamics and

efficacy of some insecticides against aphid on okra. Journal of Crop and Weed Science. 2013; 37(2):109-123.
9. Kumawat RL, Pareek BL, Meena BL. Seasonal incidence of jassid and whitefly on okra and their correlation with abiotic factors. Annals of Biology. 2000; 16(2):167-169.
10. Lal H, Mahal MS, Singh R, Singh B. Influence of rainfall on population build-up of *Amrasca biguttula* (Ishida) on 'Okra'. Journal of Insect Science. 1990; 3:169-171.
11. Meena NK, Kanwat PM, Meena A, Sharma JK. Seasonal incidence of jassids and whiteflies on okra, *Abelmoschus esculentus* (L.) Moench in semi-arid region of Rajasthan Annals of Agri Bio Research. 2010; 15(1):25-29.
12. Men VB, Sarniaik DN, Prehkar LN, Deshmukh SD, Muqueem A, Nachane MV *et al.* Effect of weather factors on the population of jassids. PVK. Research Journal. 1996; 20(2):151-154.
13. Nath L, Prasad CS, Tiwari GN, Kumar A. Impact of weather parameters on major insect pests of okra prevailing Western Uttar Pradesh. Society for plant research. 2011; 24(2):152-156.
14. Peirce LC. Vegetables: Characteristics, Production and Marketing. John Wiley and Sons, Canada, 1987, 399-401.
15. Sahito HA, Abro GH, Memon SA, Mal B, Mahmood R. Influence of abiotic factors on population development of *Bemisia tabaci* infesting *Abelmoschus esculentus.* International Research Journal of Plant Science. 2012; 3(2):12-18.
16. Saroj AK, Singh AK, Singh DC, Kumar S. Population dynamics of jassid, *Amrasca biguttula* (Ishida) in okra, *Abelmoschus esculentus* (L) and its correlation with meteorological parameters. Plant Archives, 2017; 17(2):1189-1190.
17. Selvaraj S, Adiroubane D, Ramesh V. Population dynamics of important insect pest of hindi in relation to weather parameters. Pestology. 2010; 34:35-39.
18. Sharma RK, Sundaram AM, Sharma K, Venkateswarlu V, Anand GKS. Population fluctuation of pest complex of okra and cabbage in relation to abiotic factors. National Seminar on Indian Agriculture: Preparedness for Climate Change, 1997, 7.
19. Shivanna BK, Gangadhara Naik B, Basavaraja MK, Nagaraja R, Kalleswara Swamy CM, Karegowda C. Impact of Abiotic Factors on Population Dynamics of sucking pests in transgenic cotton ecosystem. International Journal of Science and Nature. 2011; 2(1):72-73.
20. Siddartha D, Kotikal YK, Venkateshalu, Durdundi S. Seasonal incidence of sucking pests on Okra. G.J.B.B. 2017; 6(2):245-250.
21. Soni R, Dhakad NK. Seasonal Incidence of Cotton Jassid, *Amrasca biguttula biguttula* (Ishida) on Transgenic *BT* Cotton and Their Correlation with Weather Parameters. International Journal of Agriculture Innovations and Research. 2016; 4(6):2319-1473.
22. Yadav A, Ali S. Bio efficacy and economics of neem based formulations against Dasyneura lin. Annals of Plant Protection Sciences, 2008; 16: 350-352.
23. Yokomi RK, Gottwald TR. Virulence of *Verticillium lecanii* isolates in aphids determined by bioassay. Journal of Invertebrate Pathology. 1998; 51:250-258.