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Seasonal incidence of sucking insect-pest in okra and their correlation with weather parameters in condition of western U.P.

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Abstract
Investigation on seasonal incidence of sucking pest of okra and its relationship with weather parameters was carried out at Crop Research Centre (CRC) of Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut, *Zaid* 2021 and 2022. The incidence of leafhopper, *Amrasca biguttula biguttula* (Ishida), aphid, *Aphis gossypii* (Genn.) and whitefly, *Bemisia tabaci* (Genn.) were observed on okra crop during two consecutive seasons. The data revealed that the population of leafhopper, aphid and whitefly were started 12-14 days after sowing in both season. The infestation of leafhopper, aphid and whitefly reached to its peak period in the 17th SMW *i.e.*19.00 leafhopper/3 leaves, 16.20 aphid/3 leaves and 17.00/ 3 leaves during *Zaid*, 2021. The highest infestation of leafhopper, aphid and whitefly were recorded on 17th SMW (20.60 leafhopper/ 3leaves), 16th SMW (14.80 aphid/3 leaves) and 16th SMW (14.40 whitefly/3 leaves), respectively during *Zaid*, 2022. There was positive correlation between pest populations with maximum temperature (leafhopper r= 0.752 and r=0.761, aphid r= 0.747 and r=0.691, whitefly r= 0.738, r=0.661) and only relative humidity was negatively correlated (leafhopper r= -0.825 and r= -0.844, aphid r= -0.720 and r= -0.749, whitefly r= -0.752, r= -0.724) in both season. The population of leafhopper was correlated positively non-significant while aphid and whitefly population were correlated significantly positive during *Zaid*, 2021 and *vice versa* in *Zaid*, 2022. The data revealed that the correlation between total rainfall and leafhopper population was negatively non-significant (r= -0.091 and r= -0.245) and aphid was positively non-significant (r=0.047 and r= 0.362) in both year while whitefly was correlated positively non-significant (r=0.022) and negatively non-significant (r= -0.357) in *Zaid*, 2021 and 2022, respectively.

Keywords: Seasonal, incidence, sucking, parameters, western

Introduction
Vegetables are universally acknowledged indispensable part of human diet which constitutes an important item of our food, supplying vitamins, carbohydrates and minerals needed for a balanced diet. Among the cultivated fruit vegetables grown in the country, okra (*Abelmoschus esculentus* L. Moench) is one of the important commercially cultivated vegetable crops popularly called as Bhindi or Lady's finger. It is used in various culinary preparations like sabji, curry, fries and also eaten raw as a salads. Okra is one of the drought tolerant vegetable species of the world and can tolerate poor soils with heavy clay and intermittent moisture. In India, okra is an important vegetable crop grown in summer and rainy seasons. The domestic production of India is 65.05 thousand MT in an area of 52.6 thousand ha (NHB 2019-20) [2]. India's production has been estimated to be around 13.40 MT per hectare. Within the country, West Bengal has the most okra-covered land, with 77.55 thousand ha, and ranks second in output with 914.86 thousand MT, whereas Gujrat has the most okra-covered land, with 921.72 thousand MT. Uttar Pradesh, on the other hand, has a total of 22.93 thousand ha under cultivation, producing 307.29 thousand MT of okra every year. Agra, Meerut, Lucknow, and other regions are major producers of okra (Anonymous, 2018) [1]. Okra crop, right from germination to harvesting is attacked by about 72 species of insect pests (Rao and Rajendran, 2003) [8]. The major insect pests are shoot and fruit borer, *Earias vittella* (Boisd.), leaf hopper, *Amrasca biguttula biguttula* (Ishida), whitefly, *Bemisia tabaci* (Genn.) and aphid, *Aphis gossypii* (G.) (Meena and Kanwat, 2005) [9]. Out of these shoot and fruit borer, leaf hopper and whitefly are major insect pests, of okra (Kumar *et al.*, 2014). The leafhopper, a polyphagous pest, has been a problematic pest on okra in recent years, generating massive losses. A large population of leafhoppers suckers cell sap from the ventral surface of the leaves and injects toxic saliva into the plant tissues, making the leaves yellow and curling upward (Singh *et al.*, 2008) [14].

Leafhoppers cause 40 to 56 per cent of yield loss in okra, resulting in reductions of 49.8 and 45.1 per cent in plant height and number of leaves, respectively (Rawat and Sadu, 1973) [11], which de-sap the plants and make them feeble. In the early stages of the infestation, aphids and leafhoppers caused 50 to 55 per cent of the damage **(**Chaudhary and Dadeech, 1989) [3]. The whitefly (*Bemisia tabaci*) not only harms the crop by sucking the cell sap and secreting honeydew on the leaves, but it also spreads the disease okra yellow vein clearing mosaic virus. It is critical to manage the pest population at the appropriate time with adequate management strategies in order to prevent insect pest infestations and produce a quality crop. As a result, knowing the incidence of insect pests in changing climatic situations is critical during research. As a result, research was conducted to determine the correlation of insect pests, populations, and weather parameters in order to determine the hospitable conditions for insect development.

Materials and Methods

Investigations on seasonal incidence of sucking insect-pest and correlation with abiotic factors during *Zaid*, 2021 and 2022, infesting okra was carried out under field condition during *Zaid* season of 2021 and 2022 at Crop Research Centre (CRC) of Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut, India which geographically located at lies between 29° 17' N latitude and 77° 42' longitude at an altitude of 237 meter above mean sea level. To monitor the insect-pests on okra, variety Nidhi-98, was sown on last week of February 2021 and 2022 in the plots size 10 X 5 m^2 having simple layout. Row to row and plant to plant distance was kept 60 and 30 cm, respectively.

Method of observation

For recording the observations, five plants were randomly selected and record the pest populations. The observations of leafhopper, aphid and whitefly were recorded at weekly interval right from germination to harvesting of the crop. The population of sucking insect pests (leafhopper, aphid and whitefly) were counted in early morning hours of the day (before 8 AM) when they remained less active by visual count on three leaves, *i.e.* one each from top, middle and bottom of tagged plants (absolute counting) (Yadav, 2015, Thakkar and Rote, 2001 and Sharma and Sinha, 2009) [16, 15, 13]. All the stages of nymphs and adults of these pests were taken into account while counting. The leafhopper and whitefly on upper surface of leaves were counted first and then on lower surface by gentle turning, taking all possible care not to disturb them.

Result

Seasonal incidence of leafhopper/jassid in relation to abiotic factors

Zaid, 2021

The population of leafhopper, *A. biguttula biguttula* recorded during the crop season, *Zaid*, 2021 on variety Nidhi-98, has been presented in table-1 and Figure-1 along with meteorological parameters *viz.*, minimum and maximum temperature, relative humidity and rainfall. The data revealed that the jassid population commenced in the 10th SMW and the first observation was recorded on 6th March. Initially, the population of leaf hopper was low (0.40 leaf hoppers/ three leaves). The population gradually increased and reached the peak in 17th SMW (16.20 jassid/ three leaves). A gradual decline in the pest population was evident thereafter. The populations was 1.80 jassid/ three leaves in the 22nd SMW and observed in traces thereafter.

The maximum temperature was lowest in the 9th SMW (30.47 ^{0}C) and highest in the 18th SMW (38.77^0 C). The minimum temperature was observed in the range of 14.54^0 C to 24.19 ^{0}C, the minimum being in the 10th SMW and maximum in the 18th SMW. The relative humidity during the crop season was in the range of 29.79 to 58.93 per cent, the minimum during the 15th SMW and maximum in the 9th SMW. The highest jassid population, *viz*., 19.00 leaf hoppers/ three leaves was observed at 20.93 ^{0}C minimum temperature, 37.27 ^{0}C maximum temperature and 31.07 per cent relative humidity.

As evident in table-3 the correlation coefficient worked out revealed that the infestation of jassids on okra crop showed non-significant correlation with minimum temperature (r = 0.489) and rainfall (r = -0.091), while significant correlation with maximum temperature (r = 0.752) and negatively significant with relative humidity (r = -0.825) at 5 per cent level of significance.

Zaid, 2022

The jassid population was initiated during vegetative stage of the crop in the last week of May, 2021. The jassid remained active till the last picking okra fruits. The lowest jassid population (0.60 jassids/three leaves) was recorded during the first week of March *i.e.* 11th SMW along with its highest population (20.60 jassids/three leaves) during the 17th SMW when maximum and minimum temperature and humidity were 41.60^0 C, 23.50^0 C and 26.10 per cent, respectively.

The correlation of coefficient showed that the maximum temperature and minimum temperature indicated positive correlation with r = 0.761 and r = 0.605, respectively while significant negative with average relative humidity (-0.844) and rainfall indicated negative non-significant correlation (-0.245) at 5 per cent level of significance.

Seasonal incidence of aphid in relation to abiotic factors

Zaid, 2021

Observation recorded on aphid population revealed that activity of aphid started from first week of March (10th SMW) and continued up to the crop termination *i.e.* last week of May. The maximum aphid population (16.20 aphids/three leaves) was recorded in third week of April (17th SMW), when maximum and minimum temperature and humidity were 37.27^{0}C, 20.93^{0}C and 31.07 per cent, respectively. The minimum aphid population was recorded after two week of sowing *i.e.* 10th SMW with 0.40 aphids/three leaves.

The infestation was significantly positively correlated with the Maximum temperature (0.747) and minimum temperature (0.588) while non-significant with rainfall (0.047). Average relative humidity (-0.720) showed significant negative correlation at 5 per cent level of significance.

Zaid, 2022

The aphid population was initiated during vegetative stage of the crop in the last week of February, 2022. The aphid remained active till the last picking of okra fruits. The lowest aphid population (0.40 aphid/ three leaves) was recorded in last week of February *i.e.* 10th SMW. The highest aphid population, *viz*., 14.80 aphids/ three leaves was observed at 20.60^0 C minimum temperature, 41.60^0 C maximum temperature and 27.04 per cent relative humidity.

Correlation studies revealed that the infestation by aphid was non-significant positively correlated with minimum temperature (0.453) and rainfall (0.362) while significantly

positive with maximum temperature (0.691) and significantly negative correlation with average relative humidity (-0.749).

Seasonal incidence of whitefly in relation to abiotic factors

***Zaid*, 2021**

The data revealed that the whitefly population started in the 11th SMW and the first observation was recorded on 6th March. Initially, population of whitefly was low (0.40 whiteflies/ three leaves). The population gradually increased and reached the peak in 17th SMW (17.00 whiteflies/ three leaves). A gradual decline in the pest population was evident thereafter. The population was 1.20 whiteflies/ three leaves in the 22nd SMW. The maximum whitefly population, *viz.*, 17.00 whiteflies/ three leaves was observed at 20.93^0 C minimum temperature, 37.27^0 C maximum temperature and 21.07 per cent relative humidity. The infestation was significantly positively correlated with the minimum temperature (0.738) and maximum temperature (0.561) while rainfall (0.022) was non-significant positively correlated. Average relative humidity showed the significantly negative correlation (-0.752) at 5 per cent level of significance.

***Zaid*, 2022**

The observations on population of whitefly, *B. tabaci* on okra crop were recorded 14 days after sowing and till maturity of the crop. Whitefly population ranged between 0.40 to 14.40 whitefly/ three leaves during *Zaid*, 2022. The infestation commenced in the first week of March (10th SMW) and remained active throughout the crop season, *i.e.* third week of May during *Zaid*, 2022 (Table-.. and Figure-..). In the starting the population of whitefly was very low but it increased gradually and reached to its peak in the 16th SMW when maximum and minimum temperature and humidity were 41.2^0 C, 20.6^0 C and 27.40 per cent, respectively with 0.10 mm rainfall. The population of whitefly reached to low level in the last week of May (22nd SMW) with the population of 1.40 whitefly/ three leaves.

Data of correlation reveals that the infestation was non-significant positively correlated with minimum temperature (0.419) and non-significant negatively with rainfall (-0.362) while average relative humidity indicated significantly negative correlation (-0.724). Maximum temperature showed positive correlation (0.661) at 5 per cent level of significance.

Discussion

Similarly, Jat and Singh, (2019) [5] reported that the infestation of leafhopper commenced in second week of March (11th SMW) and reached to its peak in the first week of May and third week of April, 2017 and 2018, respectively. The leaf hopper population had positive significant correlation with maximum and minimum temperature (r= 0.74, r=0.66, and r= 0.57, r=0.56 respectively) in 2017 and 2018. The whitefly population exhibited positive significant correlation with (r= 0.65), (r=0.55) maximum, (r=0.60) minimum temperature during 2017 and 2018 and while whitefly populations had negative significant correlation (r= -0.55, r= -0.53) with rainfall during both the year. Similarly, During the experimental period Jaysimha *et al.*, (2012) [6] reported that the leafhopper population had a significant positive correlation with the maximum temperature and a significant negative correlation with rainfall. The results of the present study are in confirmation with the findings of Sapkal *et al.*, (2022) [12] who observed that the population of jassid and aphid were started during 10th SMW while, whitefly during 11th SMW and reached its peak level in 16th (20.75), 15th (12.25) and 14th (5.80) SMW respectively. Correlation of pest incidence and weather parameters revealed that the population of jassid, aphid and whitefly showed positively highly significant correlation with maximum temperature (r=0.713**), (r=0.813**), (r=0.783**) while, positively significant correlation with minimum temperature (r=0.671*), (r=0.623*) and (r=0.612*) respectively. Similarly, the data revealed that peak population of jassid (16.1 jassid/3leaves) and whitefly (15.7 whitefly/3 leaves) was observed at 17th and 16th standard meteorological week of summer 2016, respectively. Whereas, in summer 2017 the peak population of aphid (17.8 aphid/3 leaves) was observed at 16th standard meteorological week. There was positive correlation between pest population with maximum temperature (0.545), minimum temperature (0.370) Dhandge *et al.*, (2018) [4]. The results of the present study are in dissimilar with the findings of Meena *et al.*, (2020) [9]. They reported that the correlation analysis showed that the aphid population has significantly positive correlation with morning RH, evening RH, average RH and maximum temperature and positive non-significant correlation with average temperature. Further, negative non-significant correlation showed with minimum temperature, while rainfall showed significant negative correlation with aphid population. Correlation analysis of certain abiotic factors with Jassid and whitefly revealed that the population also showed positive correlation with temperature and relative humidity. However, the pests population showed negative correlation with rainfall.

Table 1: Seasonal incidence of sucking insect-pest and abiotic factor during *Zaid*, 2021

SMW	Mean population of sucking insect			Temperature (°C)		Average Relative Humidity (RH%)	Total rainfall (mm.)
	Leafhopper	Aphid	Whitefly	Maximum	Minimum		
9	0	0	0	30.47	17.69	58.93	0.20
10	0.40	0.40	0	32.26	14.54	54.00	0.00
11	0.80	0.80	0.60	31.69	15.74	51.93	0.10
12	1.60	2.40	1.40	32.99	16.63	56.79	0.00
13	3.00	4.60	2.80	34.01	16.86	53.50	0.00
14	6.60	7.00	6.20	35.09	17.84	37.57	0.00
15	11.20	9.40	9.80	38.26	19.26	29.79	0.00
16	17.80	13.80	14.80	37.01	20.84	34.36	0.10
17	19.00	16.20	17.00	37.27	20.93	31.07	3.40
18	14.60	14.80	14.20	38.77	24.19	36.21	1.00
19	8.40	11.80	11.20	36.14	22.76	56.43	13.80
20	5.80	8.60	7.80	33.39	21.97	46.79	95.40
21	3.80	4.80	3.60	34.63	22.11	54.64	4.20
22	1.80	1.80	1.20	37.69	24.16	46.57	33.70

Table 2: Seasonal incidence of sucking insect-pest and abiotic factor during *Zaid*, 2022

SMW	Mean population of sucking insect			Temperature (°C)		Average Relative Humidity (RH%)	Total rainfall (mm.)
	Leafhopper	Aphid	Whitefly	Maximum	Minimum		
9	0	0	0	30.47	58.93	58.93	0.20
10	0	0.40	0.40	32.26	54.00	54.00	0.00
11	0.60	1.00	1.20	31.69	51.93	51.93	0.10
12	1.80	2.40	2.40	32.99	56.79	56.79	0.00
13	4.00	5.20	4.80	34.01	53.50	53.50	0.00
14	8.80	7.80	8.00	35.09	37.57	37.57	0.00
15	12.80	10.80	10.60	38.26	29.79	29.79	0.00
16	18.20	14.80	14.40	37.01	34.36	34.36	0.10
17	20.60	11.60	10.80	37.27	31.07	31.07	3.40
18	15.20	9.20	7.80	38.77	36.21	36.21	1.00
19	14.40	6.60	6.20	36.14	56.43	56.43	13.80
20	10.40	4.40	3.40	33.39	46.79	46.79	95.40
21	6.40	2.20	2.20	34.63	54.64	54.64	4.20
22	2.60	1.40	1.40	37.69	46.57	46.57	33.70

Table 3: Correlation coefficient between incidence of sucking insect-pest on okra and abiotic factors during *Zaid*, 2021

Insect-pests	Temperature (°C)		Average Relative Humidity (RH%)	Total rainfall (mm.)
	Maximum	Minimum		
Leafhopper/Jassid	0.752*	0.489^{NS}	-0.825*	-0.091^{NS}
Aphid	0.747*	0.588*	-0.720*	0.047^{NS}
Whitefly	0.738*	0.561	-0.752*	0.022^{NS}

*Significant at 5% level (P=0.05)
NS- Non significant

Table 4: Correlation coefficient between incidence of sucking insect-pest on okra and abiotic factors during *Zaid*, 2022

Insect-pests	Temperature (°C)		Average Relative Humidity (RH%)	Total rainfall (mm.)
	Maximum	Minimum		
Leafhopper/Jassid	0.761*	0.605*	-0.844*	-0.245^{NS}
Aphid	0.691*	0.453^{NS}	-0.749*	0.362^{NS}
Whitefly	0.661*	0.419^{NS}	-0.724*	-0.357^{NS}

*Significant at 5% level (P=0.05)
NS- Non significant

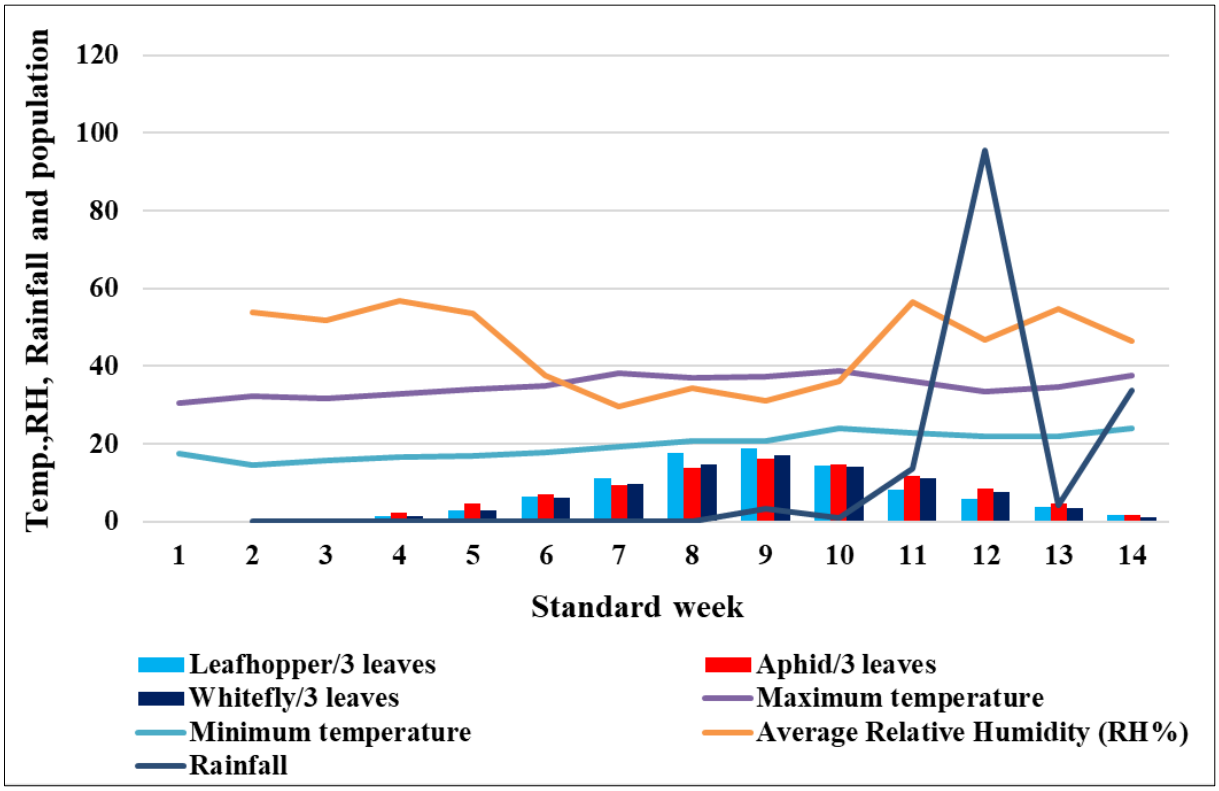

Fig 1: Incidence of leafhopper, aphid and whitefly on okra and abiotic factors during *Zaid*, 2021

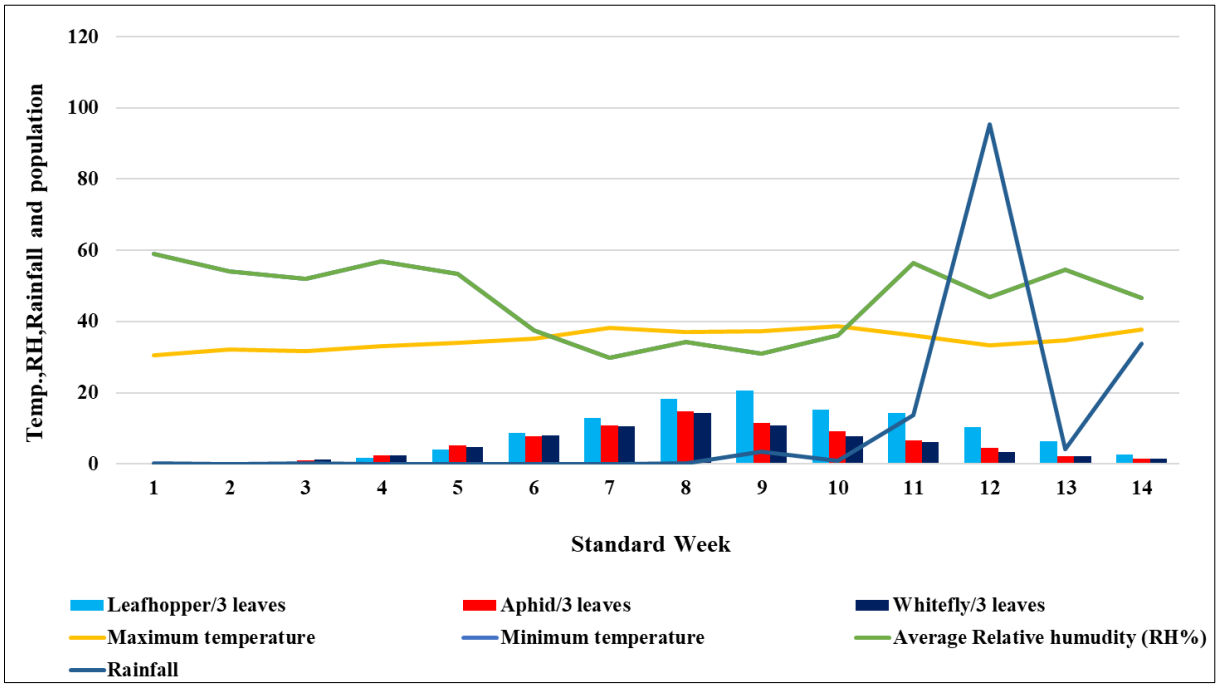

Fig 2: Incidence of leafhopper, aphid and whitefly on okra and abiotic factors during *Zaid*, 2022

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