Original Research Article

SUCCESSION OF MAJOR PESTS AND PREDATORY FAUNA IN OKRA

ABSTRACT

Investigations on pest succession in okra crop was carried out during *kharif*, 2023 at Department of Entomology, B. A. College of Agriculture, AAU, Anand. Pest succession based on crop growth stages showed that the population of sucking insect-pests *viz*., jassid (*Amrascabiguttulabiguttula*Ishida), aphid (*Aphis gossypii* Glover), whitefly (*Bemisiatabaci*Genn.) observed from vegetative stage and remained up to crop matured while, red spider mite, *Tetranychuscinnabarinus*incidence appeared from reproductive stage to maturity stage. Among the lepidopteran pests, the infestation of semilooper started in the second week after germination and remained till maturity of the crop whereas*, shoot and fruit borer*(*Eariasinsulana*Boisd.)and fruit borer (*Helicoverpaarmigera*(Hubner) Hardwick)damaged the crop from vegetative stage and remained up to crop maturity. Coccinellids and spider activity initiated with sucking insect-pest incidence and remained up to crop maturity. The weather parameters, Bright sunshine, maximum temperature and minimum temperature had significant relationships with jassid, red spider mite, *E.vittella* and *H. armigera*. Whereas, relative humidity significantly negatively influenced the activity of red spider mite, *E.vittella*, *H. armigera*and positively on predator coccinellids. Furthermore, windspeed had significant positive association with jassid and *E.vittella*(shoot damage) while, negative with *H. armigera*larva.

Keywords: *okra, succession, insect-pests, predatory fauna, abiotic factors, correlation*

1. INTRODUCTION

Cultivated okra [*Abelmoschus esculentus* (L.) Moench], a member of the Malvaceae family, is an important vegetable crop grown in India. However, insect-pest attacks and disease infestation are the important limiting factorsin okra production, with total yield losses of approximately 35-40% (Mohankumar etal.[1]; Rai[2]). The major reported insect-pest include jassid (*Amrascabiguttulabiguttula*Ishida),aphid(*Aphisgossypii*Glover),whitefly(*Bemisiatabaci*Genn.),shootand fruit borer(*Eariasinsulana*Boisd.) and (*Eariasvittella*Fab.) and fruit borer (*Helicoverpaarmigera*(Hubner) Hardwick) (Kanwar and Ameta, [3]). Among these, shoot andfruit borers are reported to cause 16 to 26 per cent damage to okra shoots and 40 to 60 per cent losses of fruits in India (Pareek and Bhargava, [4]). Jassid nymphs and adults suck plant sap from the lower surfaceoftheleaves andinjectanecrotictoxin,limitingphotosynthateabsorptionandcausingbrowning, bronzing, cupping, wilting, and necrosis of the leaves (Raghuwanshiet al. [5])which results in severe yield lossesof about about 40-56 percent in okra (Krishnaiah, [6]).Jassids and aphids are known to infest during the early stage of crop growth, leading to about 54.04 per cent (Chaudhary and Dadeech, [7]). Whitefly is also responsible for the yield loss of about 80 to 90 per cent. The red spider mite, *T. cinnabarinus* also has assumedthestatus ofamajorpestandcauseda17.46 per cent

yieldlossinokra. (Sarkar etal.[8]). Keeping this in view, the present studies were undertaken to succession and incidence of insect pest and their natural enemies on okra.

2. MATERIALS AND METHODS

The research work was carried out at the Entomology farm, Anand Agricultural University, Anand, Gujarat (22.56 ºN and 72.95 ºE) during *Kharif*, 2023.Okra cultivar Gujarat Anand Okra-5 (GAO-5) was sown in an experimental plot of 116.64 m^2, which was divided into six equal quadrates (5.4 x 3.6 m) to record various pests and predatory fauna. Observations were done at weekly interval on randomly selected ten plants per quadrate.

2.1 Methodology

The incidence of leafhopper, *A. biguttulabiguttula*; aphid, *A. gossypii*; and whitefly, *B. tabaci* population were counted from three (upper, middle and lower) leaves whereas; mite, *T. cinnabarinus* population was recorded from the same leaves of 1 cm^2 area of the same selected plants in each quadrate. The incidence of okra shoot and fruit borer (*Eariasvittella*Boisd.) was recorded based on the number of healthy and damaged shoots and fruits starting from one week after germination to crop termination whereas, the incidence of fruit borer [*Helicoverpaarmigera*(Hubner) Hardwick] in okra was observed based on the number of larva(e) as well as number of healthy and damaged fruits. Damaged fruits due to fruit borer was recorded at each picking by counting the number of healthy and damaged fruits. Thus, data on healthy and damaged shoots and fruits were converted into percentage by adopting the formula given by Mandal et al. [9].The population of predatory fauna (coccinellids and spiders) was also recorded from the randomly selected same ten plants starting from one week after germination until the crop termination.To study the effect of weather parameters on population fluctuation of various pests, the data of physical factors of environment viz., bright sunshine (BSS), rainfall (RF), wind speed (WS), maximum (MaxT) and minimum (MinT) temperature, morning (RH_1) and evening (RH_2) relative humidity were correlated. Week-wise data on various parameters were recorded by Department of Meteorology, B. A. College of Agriculture, Anand Agricultural University, Anand during *kharif*, 2023. Simple correlation between various pests and their predatory fauna as well as with weather factorswas worked out using their weekly mean incidence by adopting a standard statistical procedure (Steel and Torrie, [10]). The statistical analysis was carried out using SPSS software version 22.0 (IBM, New York, USA).

3. RESULTS AND DISCUSSION

3.1 Succession of pests and predatory fauna in okra crop

The data presented in Table 1 revealed that about seven species of pests and two species of predatory fauna were observed which were associated with various growth stages of the okra crop.The okra crop was first attacked by semilooper, *Anomis flava* at the early stages of the okra crop *i.e.*vegetative stage whereas, the population of jassid, aphid and whitefly occurred at the succeeding stages and persisted till the maturity of the crop.The next incidence in the okra crop was fruit borer *H. armigera*whichcaused damage to okra leaves during vegetative stage and was observed feeding on

Table 1: Succession of pests and predatory fauna in okra crop (*kharif*,2023)

Sr. No	Common name	Scientific name	Crop growth stage	Occurrence	Economic status
1	Jassid	*Amrasca biguttula biguttula* (Ishida) (Cicadellidae, Hemiptera)	Vegetative to maturity stage	Regular	Major
2	Aphid	*Aphis gossypii* (Glover) (Aphididae, Hemiptera)	Vegetative to maturity stage	Regular	Major
3	Whitefly	*Bemisiatabaci* (Gennadius) (Aleyrodidae, Hemiptera)	Vegetative to maturity stage	Regular	Major
4	Red spider mite	*Tetranychusurticae* (Koch) (Tetranychidae, Trombidiformes)	Flowering to maturity stage	Regular	Major
5	Shoot and fruit borer	*Eariasvittella* (Fabricius) (Noctuidae, Lepidoptera)	Vegetative to maturity stage	Regular	Major
6	Fruit borer	*Helicoverpa armigera* (Hubner) (Noctuidae, Lepidoptera)	Vegetative to maturity stage	Regular	Major
7	Semilooper	*Anomis flava* (Erebidae. Lepidoptera)	Vegetative to maturity stage	Regular	Major
8	Coccinellids	-	Vegetative to maturity stage	Regular	-
9	Spiders	-	Vegetative to maturity stage	Regular	-

the flowers as well as fruits during the reproductive stage. While, shoot and fruit borer (*E. vittella*) infestation had occurred first in plant shoots and later on bored inside the fruits. Both the lepidopteran pests persisted till the maturity of the crop. The last pest to occur in the okra crop was red spider mite (*T. urticae*) which occurred during the reproductive stage and remained in the crop up to termination of the crop. In the case of predatory fauna in the okra crop, various species of coccinellids and spiders were recorded from vegetative to maturity. The present findings were in agreement with agreement with the studies conducted by Pandey and Koshta [11], Raghuwanshi et al. [5], Das et al. [12], Chandra [13] and Anjanaet al. [14] who documented that the activity of jassid and whitefly was observed from the vegetative to the maturity stage whereas, shoot and fruit borer infestation was prominent from the reproductive to the maturity stage in the okra crop. Similarly, Chaturvedani et al. [15] also reported the incidence of aphids, jassids and whiteflies during the vegetative stage of the crop

3.1.1 Jassid, *A. biguttulabiguttula*

The jassid population commenced from the 3rd week after germination (WAG), i.e., the first week of August (31st SMW), and persisted till 42nd SMW i.e., 3rd week of October (Table 2 and Fig. 1). The population of jassid ranged from 0.68 to 7.32 with a mean population of 4.36 per leaf. The first peak population (7 jassid/leaf) was obtained during the 2nd week of September

(9th WAG and 37th SMW) whereas a second peak of 7.32 jassid per leaf was observed during the 3rd week of October (42nd SMW). These results are in agreement with the findings of Raghuwanshi*et al*. [5] observed peak activity of jassid during 2nd and 4th week of September, respectively. Similarly, the findings of Pathan et al. [16] recorded two peaks of jassid infestation *i.e.* during 37th SMW and 42nd SMW of okra crop, these results were also aligning with the results of our present investigation.

3.1.2 Aphid, *A. gossypii*

The data presented in Table 2 and depicted in Fig. 1 indicate that the incidence of aphid appeared in the 3rd WAG *i.e.* first week of August (31st SMW) and continued till 2nd week of October (41st SMW and 13th WAG). The population of aphids ranged from 0.88 to 17.28 per leaf during the season with a mean population of 6.24 per leaf. The peak activity of this pest (17.28 aphids/ leaf) was recorded during the 4th week of August *i.e.* 34th SMW (6th WAG). In the subsequent weeks, the aphid population was gradually declined and eventually disappeared by 3rd week of October (42nd SMW and 14th WAG). These results align with the findings of Pathan et al. [16] who reported that aphid activity began in the 3rd week after germination (WAG) and continued until the 11th WAG, with peak activity occurring during the 5th week of August.

3.1.3 Whitefly, *B. tabaci*

Whitefly population was initiated in the okra crop from 3rd WAG *i.e.* 31st SMW (First week of August) and continued till the 2nd week of October *i.e.* 41st SMW and 13th WAG (Table 2 and Fig. 1). Throughout the crop period, the whitefly population fluctuated between 0.06 and 3.00 per leaf with a mean population of 0.97 per leaf. The highest activity of whitefly *i.e.* 3.00 per leaf was recorded in the 2nd week of September (37th SMW and 9 WAG) and then gradually declined. The population of

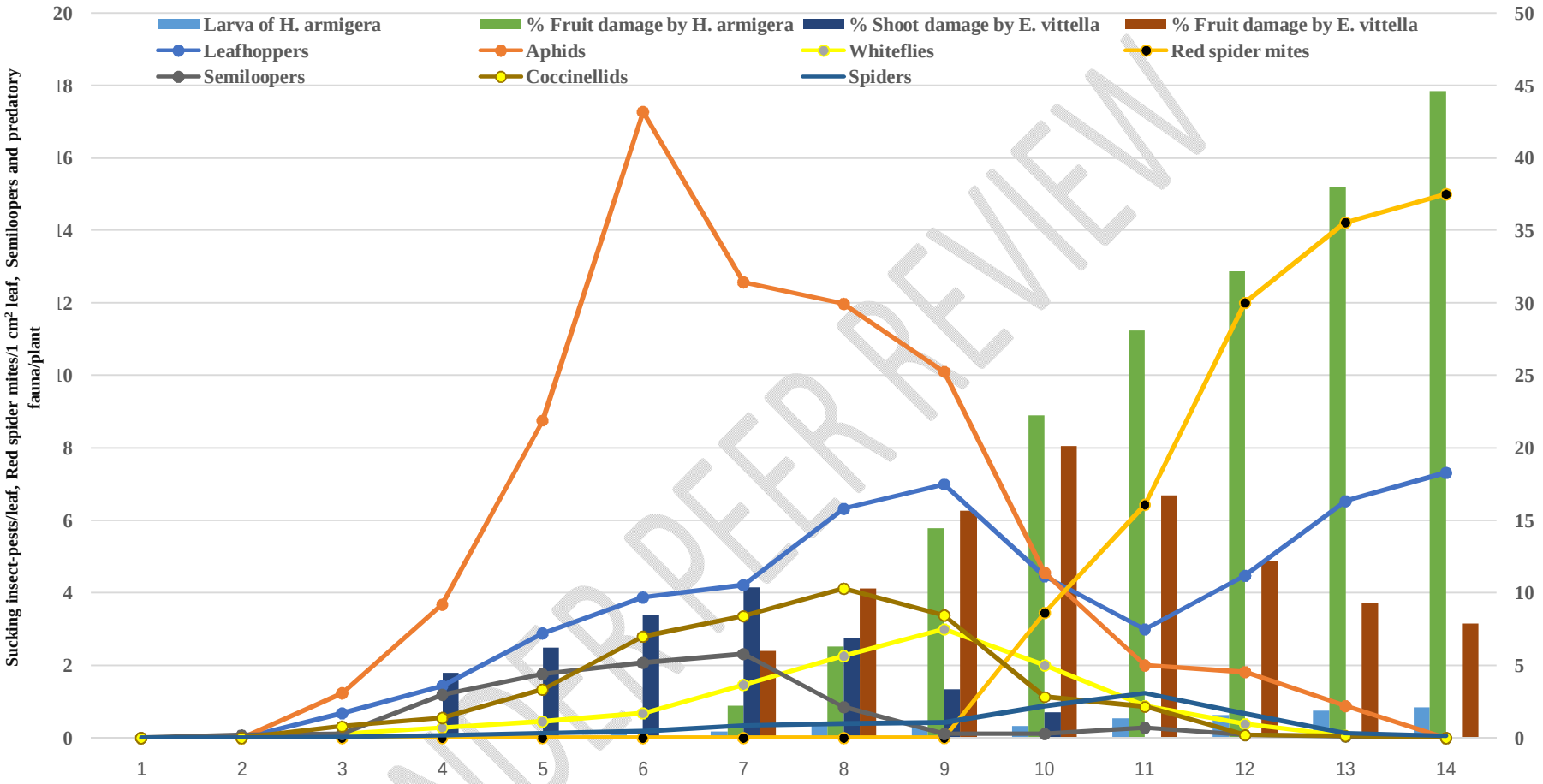
whitefly disappeared after the 2nd week of October i.e. 41st SMW and 13th WAG. The present findings are in

Table 2: Occurrence of pests and predatory fauna in okra crop (*kharif*,2023)

Month and week		SMW	WAG	No. of sucking insect-pests/leaf			Red Spider Mite/ 1 cm^2 leaf area	*E. vittella*		*H. armigera*		No. of semilooper larva(e)/ plant	Predatory fauna/plant	
				Jassid	Aphid	Whitefly		Shoot damage (%)	Fruit damage (%)	No. of larva(e) / plant	Fruit damage (%)		Coccinellids	Spiders
July	III	29	1	-	-	-	-	-	-	-	-	-	-	-
	IV	30	2	-	-	-	-	-	-	-	-	0.08	-	-
August	I	31	3	0.68	1.24	0.12	-	-	-	-	-	0.12	0.32	0.08
	II	32	4	1.44	3.68	0.28	-	4.52	-	0.06	-	1.20	0.56	0.18
	III	33	5	2.82	8.76	0.46	-	6.26	-	0.15	-	1.76	1.34	0.34
	IV	34	6	3.96	17.28	0.68	-	8.44	-	0.30	-	2.08	2.80	0.48
	V	35	7	4.28	12.58	1.46	-	10.42	6.00	0.45	2.24	2.32	3.36	0.86
September	I	36	8	6.32	11.98	2.26	-	6.88	10.22	1.00	6.32	0.86	4.12	1.00
	II	37	9	7.00	10.11	3.00	-	3.36	15.68	0.70	14.48	0.11	3.38	1.06
	III	38	10	4.46	4.56	2.00	3.45	1.76	20.12	0.85	22.28	0.12	1.13	2.24
	IV	39	11	3.00	2.00	0.88	6.44	0.00	16.72	1.36	28.12	0.28	0.86	3.12
October	I	40	12	4.48	1.82	0.38	12.00	0.00	12.22	1.60	32.16	0.08	0.08	1.68
	II	41	13	6.54	0.88	0.06	14.22	0.00	9.34	1.88	37.98	0.04	0.05	0.34
	III	42	14	7.32	0.00	0.00	15.00	0.00	7.88	2.14	44.62	0.00	0.00	0.14

Notes:1. SMW = Standard Meteorological Week

2. WAG = Week After Germination



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agreement with Pathan et al. [16] who reported that whitefly incidence occurred in 3rd week of sowing in the okra and recorded higher activity in 9th and 10th week of sowing. Khating et al. [17] also stated that the highest activity of whiteflies was observed during the month of September. However, Patel et al. [18] noted that the incidence of whitefly started in the 4th week after sowing and reached its peak level in the 8th week after sowing. These findings were more or less similar to present investigations.

3.1.4 Red spider mite, *T. cinnabarinus*

The population data for red spider mites, as presented in Table 2, indicated that they occurred during the latter part of the crop season. The population of red spider mites marked its first appearance during 3rd week of September (39th SMW and 11th WAG) and gradually increased in trend till the crop termination *i.e.* 3rd week of October (42nd SMW and 14th WAG). Red spider mite densities ranged from 3.45 to 15.00 per 1 cm^2 leaf area with a mean population of 10.22 mites per 1 cm^2 leaf.

3.1.5 Shoot and Fruit borer, *E. vittella*

The periodic activity of *E. vittella* was observed based on shoot damage and fruit damage (Table 2 and Fig. 1). The incidence of *E. vittella*on shoots has occurred in 2nd week of August (32nd SMW and 4th WAG) with 4.52 per cent shoot damage. The maximum (10.42%) shoot damage was recorded during in 5th week of August (36th SMW and 5th WAG) and then declined. The incidence of shoot and fruit borer was observed in okra shoots up to 3rd week of September (38th SMW). Shoot and fruit borer infestation in fruits of okra (Table 2 and Fig. 1) was started from 5th week of August (36th SMW and 5th WAG) with 6.00 per cent damage and endured up to crop cessation *i.e.* 3rd week of September (38th SMW and 14 WAG). The highest (20.12%) fruit damage was recorded during 3rd week of September (38th SMW and 10 WAG) and then subsequently declined. In the last week before crop termination, 7.88 per cent incidence of *E. vittella*was observed on fruits. The present findings are in close proximity with earlier investigation by Raghuwanshi et al. [5] who reported that the incidence of okra fruit and shoot borer on fruits started in the 3rd week of September and remained active up to the last picking of the fruits. Sheoran et al. [19] observed the infestation of *E. vittella*on shoots from 32nd SMW with its peak on 39th SMW while, the highest fruit damage (35.68%) due to *E. vittella* was recorded on 39th SMW by Bisen et al. [20].

3.1.6 Fruit borer, *H. armigera*

The data presented in Table 2 and illustrated in Fig. 1 indicate that the population of *H. armigera* varied from 0.06 to 2.14 per plant during the season. The occurrence of *H. armigera* was first perceived in the 4th week after germination *i.e.* 2nd week of August (32nd SMW) with 0.06 larva per plant and remained throughout the crop period. The population of *H. armigera* reached its first peak *i.e.* 1.00 larva per plant during 1st week of September (36th SMW and 8 WAG). After that, the larval population was reduced during 2nd and 3rd week of September and again attained a second peak (2.14 larva/ plat) in 3rd week of October (42nd SMW and 14 WAG). More or less the same trend was observed in fruit damage due to the larva of *H. armigera*(Table 2 and Fig 1). The incidence in okra fruits was started with 2.24 per cent from 5th week of September (35th SMW and 7 WAG) and gradually increased to 44.62 per cent fruit damage on 3rd week of October (42nd SMW and 14th WAG). Pathan et al. [16] stated that fruit infestation of *H. armigera* started in the first week of September and

reached its peak in the third week of October. Chandra [13] recorded the initiation of *H. armigera* at 7 WAS. In the present finding, *H. armigera* was first perceived in the fourth week after germination *i.e.,* the second week of August (32nd SMW) and reached to its highest peak in the third week of October. Thus, the present study is in accordance with the above conclusions drawn by earlier researchers.

3.1.7 Semilooper, *A. flava*

The observations on semilooper larva per plant in okra crop are presented in Table 2 and depicted in Fig 1. The occurrence of semilooper began in the 2nd week after germination, specifically during 3rd week of July (30th SMW) and persisted until the 2nd week of October (41st SMW and 13 WAG). The larval population of semilooper occurred between 0.04 to 2.32 per plant during the season. During 5th week of August (35th SMW and 7WAG), the activity of this pest was recorded highest with 2.32 larvae per plant. In the subsequent weeks, the semilooper population gradually declined and eventually disappeared by the 2nd week of October. The present investigations could not be discussed here due to the lack of published literature on semilooper in okra.

3.1.8 Coccinellids

The activity of coccinellids as a predator is presented in Table 2. The population of coccinellids began with 0.32 per plant in the crop after the third week of germination *i.e.* 1st week of August (31st SMW) and persisted until the second week of October (41st SMW and 13 WAG). The coccinellid population was recorded in the plot during the season from 0.32 to 4.12 per plant with a mean of 1.50 per plant. The highest activity of this natural enemy was recorded during the 1st week of September (36th SMW, 8 WAG), reaching a peak of 4.12 grubs/adults per plant. However, the coccinellids population gradually declined in the subsequent weeks and eventually disappeared by the 2nd week of October (41st SMW, 13 WAG). Das et al. [12] illustrated that the incidence of coccinellids in okra was observed at 19 days after sowing and the population persisted till the harvest of the crop during summer season. This report is more or less accordance with the present findings.

3.1.9 Spiders

The data presented in Table 2 and depicted in Fig 1 indicated that the population of spiders started to appear during 1st week of August (31st SMW). The population of spiders ranged from which 0.08 to 3.12 per plant. The peak activity (3.12 spiders/plant) was observed during the 4th week of September (39th SMW and 12th WAG). The present findings are in close proximity with the results of Khating et al. [17] who reported peak activity of spiders during the 4th week of September.

3.2 Succession between/among Pests and Natural Enemies in Okra based on Association

The data on correlation study (Table 3) between/among various pests of okra indicated that the jassid population had a significantly positive correlation with larva of *H. armigera* and its damage on okra fruit (r = 0.703* and 0.595*, respectively). Populations of aphids exhibited a highly significant positive correlation with shoot damage by *E. vittela* (r = 0.901**) and semilooper (r = 0.764**)

indicating that pests appeared concurrently on okra whereas, the population of aphid had a significant negative

Table 3: Correlation coefficient (r) between incidence of pests in okra and their predatory fauna

Insect-pests/ natural enemies	Sucking insect-pests			Red spider mite	*E. vittella*		*H. armigera*		Semilooper larva	Predatory fauna/plant	
	Jassid	Aphid	Whitefly		Shoot damage	Fruit damage	Larva	Fruit damage		Coccinellids	Spiders
Jassid	-	-	-	-	-	-	-	-	-	-	-
Aphid	0.091	-	-	-	-	-	-	-	-	-	-
Whitefly	0.392	0.518	-	-	-	-	-	-	-	-	-
Red spider mite	0.479	-0.672*	-0.473	-	-	-	-	-	-	-	-
Shoot damage by *E.vittella*	0.057	0.901**	0.342	-0.678	-	-	-	-	-	-	-
Fruit damage by *E.vittella*	0.507	-0.222	0.569	0.995*	-0.594	-	-	-	-	-	-
***H. armigera*larva**	0.703*	-0.499	-0.150	0.966**	-0.812**	-0.237	-	-	-	-	-
Fruit damage by *H. armigera*	0.595*	-0.646*	-0.203	0.943*	-0.915**	0.022	0.956**	-	-	-	-
Semilooper larva	-0.295	0.764**	0.010	-0.718	0.927**	-0.586	-0.758**	-0.611*	-	-	-
Coccinellids	0.270	0.858**	0.781*	-0.984*	0.804*	0.011	-0.501	-0.935*	0.549	-	-
Spiders	0.023	-0.110	0.388	-0.858	-0.357	0.820*	0.177	-0.106	-0.198	-0.164	-

Note: * Correlation is significant at 0.05 level; ** Correlation is significant at 0.01 level

association with red spider mites (r = -0.672*) and fruit damage by *H. armigera* (r = -0.646*). Further, aphid and coccinellids association showed a significant highly positive correlation (r = 0.858**), illustrating that the increase in aphid population also increases the coccinellid predators or *vice-versa*. The incidence of whitefly showed a significant positive correlation with coccinellids (r = 0.781*). The population of red spider mite established a highly significant positive correlation with larvae of *H. armigera* (r = 0.966**), whereas a significant positive correlation with fruit damage by *H. armigera* and *E. vittella* (r = 0.995* and 0.943*, respectively) and significant negative correlation with coccinellids (r = -0.984*). Infestation of shoot by *E. vittella* had a highly significant positive correlation with semiloopers (r = 0.927**) and highly significant negative correlation with larva of *H. armigera* and its damage on okra fruit (r = -0.812** and -0.915**, respectively). Whereas, there was a significant positive correlation with the population of coccinellids (r = 0.804*). Infestation of fruit by *E. vittella* had a highly significant positive correlation with spiders (r = 0.820*). The incidence of *H. armigera* showed a highly significant positive correlation with fruit damage by *H. armigera* (r = 0.956**) and a highly significant negative correlation with semiloopers (r = -0.758**). In the case of fruit damage by *H. armigera*, a significant negative correlation was observed with the population of coccinellids and semiloopers (r = -0.935* and -0.611*, respectively)

Earlier, Pathan et al. [16] reported a highly significant association of leafhoppers with *H. armigera* and highly significant positive association between the activity of aphids and coccinellids as well as the co-existence of *H. armigera* and red spider mites. Pandey and Koshta[11] reported a significant positive correlation between leafhoppers and fruit damage by fruit and shoot borer, *E. vittella*. Thus, the present results about the association are confirmed by the conclusion made by the above researchers.

3.3 Succession of Pests and Predatory Fauna in Okra based on Weather Factors

3.3.1 Jassid, *A. biguttulabiguttula*

The correlation study in Table 4 revealed that jassid population showed significant positive correlation with bright sunshine (BSS) and maximum temperature (MaxT) (r = 0.640* and 0.613*, respectively). While, significant negative correlations with wind speed (WS) and minimum temperature (r = -0.623* and -0.576*, respectively). However, abiotic factors viz., morning relative humidity (RH_1) and evening relative humidity (RH_2) were non-significantly negatively correlated whereas, rainfall (RF) showed non-significant positive correlation. These results were in close accordance with the findings of Biswas et al. [21] and Pandey and Koshta[11] who reported that jassid population had a significant positive correlation with MaxT.

3.3.2 Aphids, *A. gossypii*

There was no significant association between abiotic factors and population of aphids (Table 4). However, WS, RH_2 and MinT were non-significantly positively correlated whereas, BSS, RF, MaxT and RH_2 were non-significant negatively correlated.

Table 4: Correlation coefficient (r) between weather factorsand pests infesting okra crop as well as their predatory fauna

Weather factors	Sucking insect-pests			Red spider mite	*E. vittella*		*H. armigera*		Semilooper larva	Predatory fauna/plant	
	Jassid	Aphid	Whitefly		Shoot damage	Fruit damage	Larva	Fruit damage		Coccinellids	Spiders
Bright Sunshine (BSS), h/day	0.640*	-0.319	-0.110	0.942*	-0.400	-0.783*	0.812**	0.436	-0.263	-0.155	0.108
Rainfall (RF), mm	0.054	-0.017	0.530	-0.873	-0.160	0.771	-0.048	-0.191	-0.355	0.107	0.564
Wind Speed (WS), km/h	-0.623*	0.415	0.203	-0.846	0.714*	0.228	-0.956**	-0.908**	0.409	0.344	-0.356
Maximum Temperature (MaxT), °C	0.613*	-0.232	-0.201	0.931*	-0.277	-0.848**	0.754**	0.357	-0.116	-0.085	-0.032
Minimum Temperature (MinT), °C	-0.576*	0.478	0.437	-0.968**	0.609	0.439	-0.856**	-0.834**	0.339	0.512	0.064
Morning Relative Humidity (RH_1), %	-0.183	-0.185	0.292	-0.941*	-0.369	0.910*	-0.049	0.062	-0.406	-0.151	0.672*
Evening Relative Humidity (RH_2), %	-0.561	0.258	0.425	-0.999**	0.271	0.823**	-0.705*	-0.524	-0.017	0.268	0.242

Note: * Correlation is significant at 0.05 level; ** Correlation is significant at 0.01 level

3.3.3 Whiteflies, *B. tabaci*

The population of whiteflies showed no significant association with abiotic factors (Table 4). However, WS, RF, MinT, RH_1 and RH_2 showed positive correlation whereas, Bright Sunshine (BSS) and Maximum Temperature (MaxT) showed negative association.

These results were similar to the findings of Das et al. [12], who reported that MaxT, MinT, RF, RH_2 and BSS were positively and non-significantly related to whitefly populations. These findings were similar to our results. Pathan et al. [16] reported that there was no significant impact of all abiotic factors under study on the incidence of the whitefly population. However, RF, WS, MaxT and RH_1 showed a negative correlation, whereas BSS, MinT and RH_2 had a positive association with the pest. These findings are in corroboration with the present findings.

3.3.4 Fruit damage by *E. vittella*

Fruit infestation by shoot and fruit borer showed highly significant negative correlation with MaxT (r = -0.848**) and highly significant positive correlation with RH_2 (r = 0.823**) (Table 4). Whereas, fruit infestation due to shoot and fruit borer illustrated a significant positive association with RH_1 (r = 0.910*) and a significant negative correlation with BSS (r = -0.783*). The remaining physical factors showed no significant correlations.

3.3.5 Fruit borer, *H. armigera*

The correlation studies (Table 4) revealed that both WS and MinT exhibited highly significant negative correlations with *H. armigera* activity, with correlation coefficients (r) of -0.956** and -0.856**, respectively. Whereas, significant negative correlations with RH_2 (r = -0.705*). Bright Sunshine (BSS) and Maximum Temperature (MaxT) exhibited highly significant positive correlation (r = 0.812** and 0.754**, respectively).

3.3.6 Fruit damage by *H. armigera*

The correlation coefficients (r) between abiotic factors and the percentage of fruit damage by *H. armigera* presented in Table 4 revealed that WS (r = -0.908**) and MinT (r = -0.834**) exhibited a highly significant negative correlation while, the remaining weather parameters did not show any significant impact. The present findings are similar to the results Pathan et al. [16] who reported that the fruit damage by *H. armigera* exhibited a highly significant negative correlation with WS and MinT.

3.3.7 Semilooper, *A. flava*

According to the findings presented in Table 4, none of the abiotic factors significantly impacted the incidence of semiloopers in okra. However, WS and MinT were positively correlated with semilooper incidence. In contrast, BSS, RF, MaxT, RH1, and RH_2 displayed negative correlation.

3.3.8 Coccinellids

Inordertodeterminetheeffectofphysicalfactorsonthecoccinellidspopulation,acorrelationstudywa sattempted(Table4)andfoundthatallparametersunderinvestigationshowed a non-significantimpacton the fluctuationofcoccinellidspopulation. However, RF, WS, MinT and RH_2 showed a positive correlation, whereas, MaxT, RH_1 and BSS had a negative correlation with the activity of coccinellids.

These results were similar to the findings of Das et al. [12]who reported that coccinellids had a non-significant negative association with BSS and RH_1.

3.3.9 Spiders

The correlation data presented in Table 4 revealed that RH_1 (r = 0.672*) exerted a significant and positive association with the activity of spiders. Whereas other parameters did not show a significant impact on the existence of spiders. However, BSS, RF, MinT and RH_2 showed a positive correlation while, WS and MaxT had a negative correlation.

4. CONCLUSION

The present findings of this study revealed that the activity of various sucking pests and predatory fauna of okra commenced from vegetative stage of the crop and remained in the field till the maturity of the crop except red spider mite, which appeared during the flowering stage of the crop. Whereas, lepidopteran pest semilooper appeared during the vegetative stage while okra fruit borer as well as okra fruit and shoot borer infestation started during flowering stage of the crop. Weather parameters bright sunshine, maximum temperature, and minimum temperature had significant relationships with jassid, mite, *E. vittella*, and *H. armigera*. Rainfall did not influence the activity of okra insect-pests and predatory fauna. Windspeed had significant positive association with jassid and *E. vittella* (shoot damage), while negatively affecting *H. armigera* larva. However, relative humidity significantly negatively influenced the activity of red spider mite, *E. vittella*, and *H. armigera*, but had a positive impact on coccinellids.

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