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Effect of weather factors on the incidence of major insect pest on okra

DK Ghuge, SS Gosalwad and SK Patil

Abstract
An investigation on the seasonal incidence of sucking pests and fruit borers ants its natural enemies on okra was carried out at the Department of Agricultural Entomology, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani during *Kharif* 2018. The results revealed that the population of sucking pests *viz.*, aphid (*Aphis gossypi*), jassid (*Amarasca biguttula biguttula*) and whitefly (*Bemisia tabaci*) ranged between 9.20 - 56.40, 3.60 - 22.0, 1.40 -14.80 per three leaves, respectively. The first appearance of sucking pests was noticed in 29th SMW, whereas its peak period was 36th, 37th and 38th SMW, of aphid, jassid and whitefly, respectively. The first appearance of fruit borers i.e. *Earias vittella* and *Helicoverpa armigera* was noticed in 30th and 33rd SMW with 0.9 and 1.8 larvae/plant, respectively, thereafter it was increased gradually and reached its peak of 6.4 and 3.6 larvae/plant in 39th and 37th SMW, respectively. As regards correlation studies with weather factors, aphids and *E. vittella* shows negatively significant correlated with rainfall. Whitefly and *E. vittella* shows negatively significant correlated with maximum temperature. Aphids, jassids and ladybird beetles showed positively significant correlation with evening relative humidity. *E. vittella* had negatively significant correlation with wind velocity and positively significant correlation bright sunshine hours.

Keywords: Seasonal incidence, sucking pests, fruit borers, okra

Introduction

Vegetables are an essential component of human diet for maintenance of good health. They supply carbohydrates, proteins, fats, vitamins and mineral elements which are the most essential requirements of our body. Okra (*Abelmoschus esculentus* (L.) Moench) a commercial vegetable crop, commonly known as bhindi in India. India ranks first in area and production in the world. It is a major commercial vegetable cultivated all over India particularly in the states of Andhra Pradesh, West Bengal, Jharkhand, Orissa, Uttar Pradesh, Madhya Pradesh, Karnataka, Gujarat and Maharashtra. In Maharashtra, Bhendi is grown throughout the year providing continuous and good source of income to the farmers. During summer season, it fetches lucrative price due to shortage of other vegetables in the market. In India it was cultivated on an area of 528.4 thousand hectare with annual production of 6146 thousand tones and productivity of 11.60 t/ha and in Maharashtra area 14.43 thousand hectare, production 148.09 MT and productivity 10.26 t/ha (Anonymous, 2018) [3].

The problem of pests in okra is more or less similar to that of cotton crops. The major pests of okra are sucking pests and shoot and fruit borers. Sucking pests usually attack right from early seedling stage to last fruit harvesting. The important pests are aphid (*Aphis gossypii* (Glover), jassids or leaf hopper, *Amrasca biguttula biguttula* (Ishida) and whitefly, *Bemisia tabaci* (Gennadius). At the fruiting stage, the crop is severely attacked by shoot and fruit borer, *Earias vittella* (Fabricius), *Earias insulana* (Boisd) and *Helicoverpa armigera* (Hubner). Larvae bore into growing shoot of okra plant resulting in withering and drying of growing shoot on availability of fruits, larvae start feeding on them and thus cause direct loss of yield in marketable fruits. The losses in okra due to sucking pests upto 74 per cent reported by Krishnaiah (1980) [15] and the losses in the yield of okra by fruit borer were 69 per cent (Rawat and Sahu, 1975) [22].

The knowledge of seasonal incidence of insect pests at different growth stages of okra crop will be helpful in evolving proper management schedule. Pest control in okra by small-scale farmers is still heavily dependent on chemical insecticides even though their use is associated with many undesirable and sometimes lethal consequences. Improper and wide-spread use of chemical insecticides can cause under-ground and surface water pollution.

Excessive use of insecticides also induces resistance development in target pests as well as killing beneficial organisms such as pollinators (especially bees) and natural enemies (insect parasitoids and predators) (Pedigo and Rice, 2006) [19]. Okra and its pests complex forms "okra ecosystem" which also includes natural enemies living on these pests. The predatory insects like lady bird beetle, spider and aphid lion or green lacewings feeds on aphid and other soft bodied insects, it helps to control pests which feeds on okra.

The studies on population dynamics provide reliable estimates of field population densities of pests which are primary needed in pest management. It also gives an idea of population patterns and seasonal activities. Hence the present investigation was carried out with the objective to investigate the effect of weather factors on seasonal abundance of major insect pests of okra.

Material and Methods

Field experiment was conducted on seasonal incidence of major insect pests of okra during *Kharif* 2018 at Research Farm of Department of Agricultural Entomology, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani (Maharashtra), which is situated 19 16' North latitude and 76 47' East longitudes with an altitude of 408.50 meter above mean sea level. The mean annual rainfall of Parbhani is about 800-900 mm receiving mostly during June to September. Summer is hot and dry while winter is cool. The mean daily maximum temperature varied from 29.4 ^{0}C in December to 45 ^{0}C in May. The minimum temperature varies from 11.32 ^{0}C (winter) to 25.77 ^{0}C (summer). The mean relative humidity ranges from 30 to 90 per cent. The climate is subtropical. The experiment was conducted on okra crop cv. Parbhani ok in non-replicated plot design in 10 x 10 m^2 in quadrate with spacing was 60 cm × 30 cm. The crop was transplanted on 5th July 2018 and last harvesting was done at end of the crop season i.e. fourth week of October, 2018.

Observations

Five plants per quadrate i.e. 20 plants from four random locations were selected and tagged for recording the observations on sucking pests and fruit borers. Observations on population of aphid, jassid and whitefly were recorded at weekly intervals on three leaves from top, middle and bottom canopy of the selected plants commencing from ten days of transplanting and continued till harvesting. Observations on fruit borers (*Helicoverpa armigera* and *Earias vittella*) was recorded on selected plants as number of larvae per plant from each quadrate. The observation on predatory insect ladybird beetle (*Coccinellid septempunctata* Linnaeus) was also taken on five randomly selected plant from each quadrate.

Statistical analysis

Data recorded on seasonal incidence of pests and natural enemies and correlated with weather factors and for analysis simple correlation method was adopted by outlined by Gomez and Gomez (1984) [9].

Results and Discussion

The results of seasonal incidence of sucking pests and fruit borers and its natural enemies on okra was recorded and their abundance was correlated with weather parameters and the data are presented in Table 1 and 2 and depicted in figure 1.

Seasonal incidence

Aphid (*Aphis gossypii*)

The first appearance of aphids was found in 29th standard meteorological week (SMW) and it was recorded up to the last picking fruit during the season (43th SMW). The population of aphids initiated in the last week of July (29th SMW) with 9.20 aphids per 3 leaves per plant. The population increased gradually and reached at peak (45.5 aphids) in 32th SMW and then suddenly decreased in 33th and 34th SMW due to heavy rainfall. Again the population increased gradually and touched its second peak (56.4 aphids) during 36th SMW. The weather factors *viz*., maximum temperature, minimum temperature, morning relative humidity, evening relative humidity, bright sunshine hours, wind velocity and rainfall during the peak incidence were 39.09 ^{0}C, 20.08 ^{0}C, 83.86%, 61.29%, 4.90 hrs., 4.80 and 8.80 mm, respectively. These findings of present investigation are in close conformity with the earlier work carried out by Aarwe *et al.* (2016) [1] who reported that *A. gossypii* was observed with two distinct peak 36th and 37th SW (46.50 and 44.50 aphid / 30 leaves, respectively). Konar *et al.* (2013) [14] also reported that the incidence of aphid on okra was initiated during second week of July in both the years. Population of aphid was increased gradually to reach its peak during first week of September (39.28 aphids/3 leaves). Potai and Chandrakar (2018) [20] recorded that major activity period of *A. gossypii* was observed one distinct peak 40th SMW (39.24 aphid/plant). Kataria *et al.* (2017) [13] who noticed that incidence of aphids on okra was started during 36th SMW (21 days after sowing).

Jassid (*Amarasca biguttula biguttula*)

The population of jassid incidence initiated in the fourth week of July (29th SMW) with 3.6 jassids per 3 leaves per plant and the population increased gradually and touched its peak (22.2 jassids) during 37th SMW. The weather parameters *viz*., maximum temperature, minimum temperature, morning relative humidity, evening relative humidity, bright sunshine hours, wind velocity and rainfall during the peak period of incidence were 37.70 ^{0}C, 20.01 ^{0}C, 83.29%, 54.29%, 7.60 hrs., 5.30 and 2.40 mm, respectively. The present results are in line with the earlier researchers, Verma *et al.* (2010) [28] revealed that the cotton jassid, *A. biguttula biguttula* (Ishida) appeared for the first time on okra in the last week of July 2006 (1.6/plant). Kataria *et al.* (2017) [13] who reported that incidence of jassids on okra was started during 35th SMW (15 days after sowing). Aarwe *et al.* (2016) [1] revealed that major activity period of jassid (*A. biguttula biguttula*) on okra was observed from August 2014 to October 2014 with two distinct peaks during 36th and 37th SW (Standard Week). Yadav *et al.* (2007) [29] recorded that jassid activity started from the first week of August on 3-week-old crop and continued until the third week of September on 12-week-old crop and maximum population of jassid was observed in the second week of September on 8-week-old plants. LokNath *et al.* (2011) [17] recorded that the high population of 10.76 jassids/leaf of okra on 4th week of August (35th SW).Kataria *et al.* (2017) [13] who reported that incidence of jassids on okra was started during 35th SMW (15 days after sowing).

Whitefly (*Bemisia tabaci*)

The first occurrence of whitefly recorded of 1.4 whiteflies per 3 leaves per plant in 29th SMW and it was found up to the 43th SMW. The population increased gradually and peaked (14.8 whitefly) at 38th SMW. When weather parameters *viz*., maximum temperature, minimum temperature, morning relative humidity, evening relative humidity, bright sunshine hours, wind velocity and rainfall during the peak incidence were 36.41 ^{0}C, 20.70 ^{0}C, 82.71%, 48.57%, 7.90 hrs., 2.90 and 00 mm, respectively. The finding of present investigation is in close conformity with Kataria *et al.* (2017) [13] who reported that incidence of whitefly was observed during 36th SW (21 days after sowing). Aarwe *et al.* (2016) [1] reported that *B. tabaci* was appeared first week of August to last week of September 2014 with two distinct peak 34th and 35th SW (3.83 and 3.33 whiteflies / 30 leaves). Potai and Chandrakar (2018) [20] recorded that major activity period of *B. tabaci* was appeared second week of August to last week of October 2016 with one distinct peak 38th SMW (4.89 whitefly/plant). Prasad *et al*. (2008) [21] reported that the peak incidence of whiteflies observed from 41st standard week. The total influence of all the weather parameters was high and significantly on the whiteflies (60.26%) population. Sharma *et al.* (2013) [24] reported that the weather parameters played a significant role in the development of whitefly (*B. tabaci*) population on tomato. Jha and Kumar (2017) [12] who found that different environmental factors affect the population of whitefly *B. tabaci* in different extent even variation was found in same factors in different location or different time.

Shoot and fruit borer (*Earias vittella*)

It is evident from the data revealed that the incidence of *E. vittella* first appeared in 30th SMW and it was found up to the end of the season (43th SMW). The mean population of *E. vittella* initiated in the fourth week of July (29th SMW) with 0.9 larva/plant and it was increased gradually and touched its peak (6.44 larvae/plant) during 39th SMW. The weather parameters *viz*., maximum temperature, minimum temperature, morning relative humidity, evening relative humidity, bright sunshine hours, wind velocity and rainfall were 35.77 ^{0}C, 21.23 ^{0}C, 83.43%, 55.71%, 3.20 hrs., 4.00 km/hr and 1.80 mm, respectively during the peak period of incidence of the pest. Then population decreased upto end of the season. The findings are similar with the results of Selvaraj *et al*. (2010) [23] reported that the peak incidence of *E.vittella* was observed from 37th standard week (First September to mid October). Aarwe *et al.* (2016) [1] reported that *E. vittella* observed from last week of August 2014 up to crop maturity 43rd SMW with three distinct peak 36th, 40th, and 41st SMW (42.00, 41.33 and 41.67% fruit infestation). Archunan *et al.* (2018) [4] who revealed that per cent shoot damage and fruit damage by *E. vittella* on bhendi reached peak 42nd and 43rd SMW. Kumar and Saini (2005) [16] reported that the *E. vittella* peaked by the end of September. Shukla *et al.* (1997) [26] observed in summer season of 1993 and 1994, the initiation of okra shoot damage by *E. vittella* in 2 to 3 week old plants which was peak (8.5%) before fruiting.

Fruit borer (*Helicoverpa armigera*)

There was no infestation of *H. armigera* found at 29th, 30th, 31th, and 32th SMW. The lowest population (1.80 larvae/plant) was recorded during 33th SMW and reached its peak (3.60 larvae) during 37th SMW when the prevailing rainfall, maximum and minimum temperature, morning and evening humidity, wind velocity and BSS were 2.40 mm, 37.7 ^{0}C, 20.01 ^{0}C, 83.29%, 54.29%, 5.30 km/hr and 7.60 hrs/day, respectively. Then population decreased until the harvesting of the crop. The finding of present investigation is accordance with the earlier work carried out by Bhawani *et al.* (2010) [6] reported that the peak incidence of fruit borer was recorded at 38th and 39th standard weeks. Agurla *et al*. (2017) [2] recorded that the incidence of *H. armigera* on okra was commenced in the 35th standard week, peak incidence were recorded in terms of per cent fruit damage on number and weight basis 33.67 and 56.34%, respectively.

Ladybird beetle (*Coccinellid septumpuctata*)

The data revealed on natural enemies i.e ladybird beetle population was initiated in the last week of July (29th SMW) i.e. three week after sowing with 0.60 adult/plant. The population increased gradually and touched its peak (3.15 adults/plant) during 36th SMW. The weather parameters *viz.*, maximum temperature, minimum temperature, morning relative humidity, evening relative humidity, bright sunshine hours, wind velocity and rainfall during the peak period of incidence were 39.09 ^{0}C, 20.08 ^{0}C, 83.86%, 61.29%, 4.90 hrs., 4.80 and 8.80 mm, respectively. Then population decreased gradually and becomes less appearance was observed in 42th SMW, it may due to the less abudance of the pests i.e. host.

Correlation studies

The data recorded on seasonal incidence of sucking pests *viz.*, aphid, jassid, whitefly and fruit borers and its natural enemies i.e. ladybird beetle and correlated with the abiotic factors i.e temperature relative humidity, rainfall, bright sunshine hours, wind velocity are presented in Table 2.

Aphid (*Aphis gossypii*)

It is evident from the data of relationship between weather parameters and aphid population indicated significant negative correlation at 5% level of aphid with rainfall (r= -0.471). While, maximum temperature and morning relative humidity was negatively correlated but found non–significant. Wind velocity, bright sunshine hours and minimum temperature were positively correlated but found non–significant. Whereas, evening relative humidity showed significantly positive correlation at 5% level (r= 0.430). The present finding has close confirmation with results reported by Singh *et al.* (2013) [27], aphid showed negative correlation with minimum and mean temperature, rainfall, maximum and minimum relative humidity. Dabhi *et al.* (2013) [7] concluded that bright sunshine hours, temperature (maximum and minimum) and wind speed had significant positive effect on population of aphid on okra during summer season, while bright sunshine hours, maximum temperature and temperature range showed significant negative impact with aphid population.

Jassid (*Amarasca biguttula biguttula*)

The data on the relationship between weather factors and jassid population noticed significant positively correlation at 1% level of jassid with evening relative humidity (r= 0.591), while, minimum temperature, morning relative humidity and bright sunshine hour were positively correlated but found non–significant. Whereas, rainfall, maximum temperature and wind velocity negatively correlated but found non significant. The present findings are line with Mathur *et al.* (2012) [18] who observed that jassid showed significant negative correlation with both maximum and minimum temperature. Singh *et al.* (2013) [27] who found that leafhopper showed negative correlation with maximum, minimum and mean temperature, and maximum and minimum relative humidity

Whitefly (*Bemisia tabaci*)

The correlation between abiotic factors and whitefly population indicated significant negetive correlation at 5% level of whitefly with maximum temperature (r= -0.415). While, minimum temperature, evening relative humidity and bright sunshine hour were positively correlated but found non–significant. Whereas, rainfall, morning relative humidity and wind velocity showed negative correlation but found non–significant. These present finding has close confirmation with earlier work carried out by Prasad *et al*. (2008) [21] reported that both maximum and minimum temperature and rainfall were found to exert significant negative influence on whiteflies population. A study was conducted by Ghosh *et al.* (2004) [8] whitefly population was significantly and negatively correlated with average temperature, and non-significantly and negatively with average humidity and weekly rainfall. Singh *et al.* (2013) [27] who found that whitefly showed negative correlation with maximum, minimum and mean temperature and maximum and minimum relative humidity.

Shoot and fruit borer (*Earias vittella*)

The correlation of weather parameters with *E. vittella* population indicated that the significant negative correlation at 5% level of *E. vittella* with rainfall (r= -0.437) and wind velocity (r= -0.547) while, maximum temperature was negatively significant at 1% level (r= -0.644). Bright sunshine hour (r= 0.501) was found positively significant correlation at 5% level. While minimum temperature and morning relative humidity was negatively correlated but found non-significant whereas evening relative humidity positively correlated but found non–significant. The present finding are line with earlier work carried out by Gupta *et al.* (1998) [10] who reported that percent okra fruit infestation due to *E. vittella* on weight basis was positively correlated with minimum temperature (r= 0.82), morning and evening relative humidity (r= 0.79 and r= 0.88, respectively) and rainfall (r= 0.34), whereas it was negatively correlated with maximum temperature (r= -0.6194). Sharma *et al.* (2010) [25] showed that *E.vittella* population was negatively correlated with the mean temperature and mean relative humidity but non-significantly and negatively correlated with rainfall in terms of larval population and percentage of infested plants. The present finding has contradiction with work carried out by Aziz *et al*. (2009) [5], studied role of different weather factors on fluctuation of fruit and shoot infestation of spotted bollworm, *Earias* spp. and reported that maximum temperature, minimum temperature and average temperature showed a positive effect.

Fruit borer (*Helicoverpa armigera*)

The relationship between weather parameters and *H. armigera* population observed negative correlation and non-significant with rainfall, maximum temperature, minimum temperature and wind velocity, whereas morning relative humidity, evening relative humidity, and bright sunshine hours positively non–significant correlated. The present finding has similar results reported by Bhawani *et al.* (2010) [6] who showed that the per cent fruit borer incidence on okra had positive correlation with bright sunshine. Relative humidity and rainfall had a negative correlation with fruit borer infestation. Jagtap *et al.* (2008) [11] reported that before noon relative humidity and number of rainy days had highest direct positive and negative influences on larval population of *H. armigera* on okra. Agurla *et al*. (2017) [2] recorded that the maximum temperature and sunshine hours were positively correlated with larval population and fruit damage. Minimum temperature, relative humidity and rainfall were negatively correlated with larval population of *H. armigera* and fruit damage.

Table 1: Seasonal incidence of major insect pests and its natural enemies on okra

Period (2018)	Standard Meteoro-logical Week	No. of sucking pest /3 leaves/plant			No.of larvae/plant		No. of Ladybird beetle/ plant	Weather Parameters						
								Temperature (^{0}C)		Relative humidity (%)		Rainfall (mm)	BSS (hrs.)	Wind velocity (km/h)
		Aphid	Jassid	White fly	*Helicoverpa armigera*	*Earias vittella*		Max.	Min.	Morn.	Even.			
09-15 July	28	0	0	0	0	0	0	41.93	22.37	86.57	64.00	48.30	4.40	5.20
16-22 July	29	9.2	3.6	1.4	0	0	0	41.93	21.93	92.00	11.14	39.90	0.30	5.00
23-29 July	30	15.0	7.6	2.0	0	0.9	0.6	41.79	21.84	87.57	21.57	103.40	2.20	5.40
30-05 Aug.	31	24.7	9.2	3.0	0	0.5	0.8	42.00	21.94	83.14	64.57	2.20	1.50	4.90
06-12 Aug.	32	45.5	10.4	5.0	0	0.7	1.1	42.34	21.53	79.00	49.57	0	6.70	5.30
13-19 Aug.	33	5.6	12.5	4.0	1.8	1.0	1.5	42.01	22.00	84.00	68.29	7.20	2.10	6.30
20-26 Aug.	34	3.4	10.4	3.8	2.1	1.2	2.2	41.06	21.50	90.29	75.14	148.40	0.80	5.50
27-02 Sept.	35	28.4	14.8	4.3	2.8	2.8	2.5	39.93	20.54	90.57	60.29	110.20	4.80	5.80
03-09 Sept.	36	56.4	18.4	7.8	3	4.3	3.1	39.09	20.80	83.86	61.29	8.80	4.90	4.80
10-16 Sept.	37	45.2	22.2	11.5	3.6	5.3	2.4	37.70	20.01	83.29	54.29	2.40	7.60	5.30
17-23 Sept.	38	38.4	18.6	14.8	2.7	6.1	2.7	36.41	20.70	82.71	48.57	0	7.90	2.90
24-30 Sept.	39	29.8	16.4	10.5	2.1	6.4	1.6	35.77	21.23	83.43	55.71	1.80	3.20	4.00
01-07 Oct.	40	20.4	12.4	6.3	1.4	4.61	1.1	33.56	20.80	82.29	41.00	4.00	8.20	3.20
08-14 Oct.	41	15.8	8.2	5.9	1.2	3.4	0.5	33.13	19.99	77.57	39.71	0	9.00	3.40
15-21 Oct.	42	4.2	2.4	2.8	0.9	1.9	0.6	33.37	16.31	71.57	20.29	0	8.70	4.30
22-28 Oct.	43	1.0	0.8	0.8	0.6	0.6	0	32.90	16.46	75.43	27.29	0	8.80	3.20

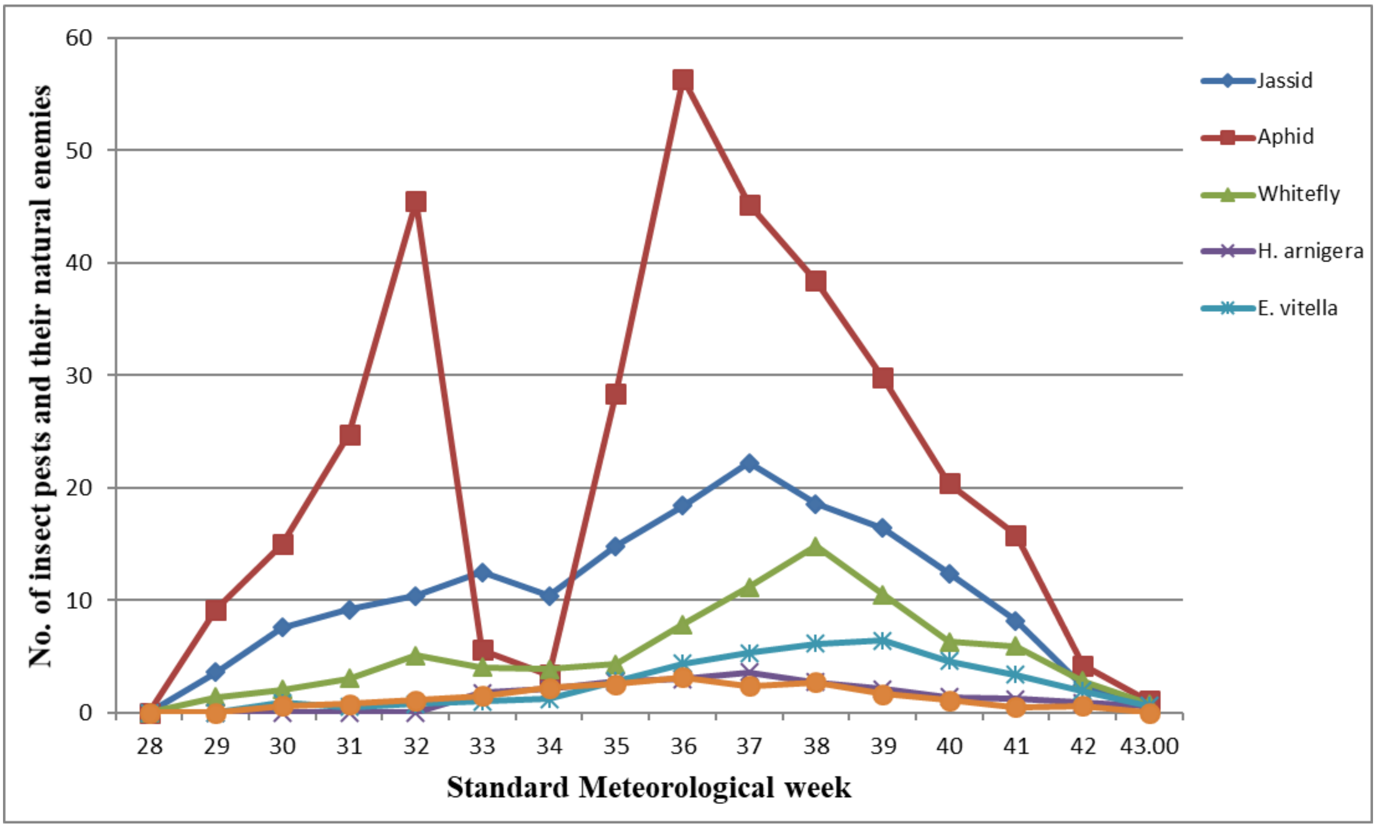

Fig 1: Seasonal incidence of major insect pests of okra and their natural enemies

Table 2: Correlation between insect pests of okra and natural enemy with weather parameters

Pests	Correlation coefficient (r)						
	Rainfall	Temperature		Relative humidity		WV	BSS
		Max.	Min.	Mor.	Eve.		
Aphids	-0.471*	-0.031	0.280	-0.034	0.430*	0.048	0.174
Jassids	-0.157	-0.140	0.307	0.128	0.591**	-0.090	0.182
Whiteflies	-0.308	-0.415*	0.102	-0.062	0.297	-0.332	0.267
E.vittella	-0.437*	-0.644**	-0.095	-0.227	0.100	-0.547*	0.501*
H.armigera	-0.057	-0.385	-0.044	0.077	0.340	-0.303	0.335
LBB	-0.111	-0.081	0.236	0.251	0.621**	0.055	0.119

*Significant at 5% level (r = 0.412)
**Significant at 1% level (r = 0.558)

Ladybird beetle (*Coccinellid septumpunctata*)
It is evident from the data on relationship between weather parameters and ladybird beetle population indicated significant positive correlation at 1% level of ladybird beetle with evening relative humidity (r= 0.621). While, minimum temperature, wind velocity, bright sunshine hour and morning relative humidity were positively correlated but found non–significant. Whereas, maximum temperature and rainfall showed non-significantly negative correlation with ladybird beetle population.

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