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POPULATION DYNAMICS OF SUCKING PESTS AND THEIR NATURAL ENEMIES IN OKRA AS INFLUENCED BY WEEDS

M. Shanthi*, G. Srinivasan and M. Kalyanasundaram

Department of Agricultural Entomology, Agricultural College and Research Institute,
Tamil Nadu Agricultural University, Madurai 625104
*Email: cshanthiento07@gmail.com

ABSTRACT

Field experiments were conducted to study the seasonal incidence of major sucking insect pests of okra viz., leafhopper, *Amrasca biguttula biguttula* Ishida, whitefly, *Bemisia tabaci* Gennadius, and aphids, *Aphis gossypii* Glover and their natural enemies viz., coccinellids and spiders of okra at Agricultural College and Research Institute, Tamil Nadu Agricultural University, Madurai, Tamil Nadu during rabi and summer seasons of 2015-16. Summer sown okra crop was more susceptible to sucking insect pests with more population of natural enemies than rabi okra crop. In rabi crop, the incidence of leafhopper commenced from third week of November 2015, aphid from third week of December 2015 and there was no whitefly incidence. In summer crop, leafhopper and aphid reached maximum in third week of April 2016, while whitefly during first week of April 2016 itself. Results revealed that leafhopper and whitefly had significant positive relationship with maximum and minimum temperature while sucking pests were negatively correlated with relative humidity and rainfall. Okra crop with partial weeding harboured more sucking insects like leafhopper, whitefly and aphids than the weed free okra plot. In addition, maximum population of natural enemies viz., coccinellids and spiders was found in partially weeded plot.

Key words: Okra, leaf hopper, whitefly, aphid, seasonal incidence, natural enemies

Okra (*Abelmoschus esculentus* (L.) Moench) is commonly known as lady's finger or bhendi. In Tamil Nadu, okra is grown in an area of 7.996 thousand hectares with the production of 56.76 thousand metric tons. Okra is infested by more than 72 species of insects, from seedling to harvest stage. Of which, leafhopper (*Amrasca biguttula biguttula* Ishida), whitefly (*Bemisia tabaci* Gennadius), aphid (*Aphis gossypii* Glover) and mealybug (*Phenococcus solenopsis* Tinsley) are the most notorious insect pests. The major symptoms of these sucking insect pests of okra include yellowing of leaves, hopper burn, crinkling and curling and reduction in photosynthesis of the plant causing loss of plant vigour and reduced crop yield (Attique et al., 2003). Among the symptoms, leafhopper causes yellowing of leaf margin and curling of the leaves and stunting followed by the death of the plant during the vegetative stage (Latif and Akhter, 2013), whitefly secretes honeydew and transmitting yellow vein mosaic virus disease (Jose and Usha, 2003), aphids causes leaves shiny and sticky due to honeydew excretion and sooty mould growth on the leaves.

The mealybug attacked plants remain stunted and produce fewer fruits of a smaller size, leaves become distorted, yellow and eventually drop off (Mark and Gullan, 2005). Most preferred weeds for sucking insect pests were *Cyperus rotundus* L. and *Portulaca oleracea* L. (Sahito and Lanjar, 2007). Insects use weeds as alternate habitat and these plants also harbour many beneficial insects and predators. To alleviate the losses due to these pests, enormous quantity of insecticides (10 to 12 sprays) is being dumped on okra (Dhandapani et al., 2003). During export there is also a risk of rejection of whole consignment due to presence of pesticide residues (Shaboizoi et al., 2011). Hence, study on seasonal incidence of insect pests in okra ecosystem is highly essential to identify the key insect pests to be managed, which in turn helps in timing the ideal and suitable management strategies. Both abiotic factors viz., temperature, relative humidity, rainfall and biotic factors like natural enemies exert their influence on the population dynamics of various pests. Keeping this in view the present study was undertaken to study a direct relationship of weather factors to the pests and their natural enemies population under partial weeded and weeded condition.

MATERIALS AND METHODS

Two field experiments were laid out during November 2015 to February 2016 (Rabi) and February

2016 to May 2016 (Summer) at Agricultural College and Research Institute, Tamil Nadu Agricultural University, Madurai. Popular hybrid (Shakti F1) seeds were sown in ridges and furrows at 45 x 45 cm spacing in 0.064 ha area. The field was divided into two equal halves for two treatments namely weeded and partially weeded plot (Rekha et al., 2009) in paired 't' test design. The two plots were separated by sowing four rows of maize in between, to prevent the movement of insect pests from one area to another. Two meter area around the experimental field was maintained as bund for weed growth (stabilizing area) to augment the population of the insect pests and natural enemies as suggested by Kandibane (2003). All the recommended agricultural practices were followed in raising the crop. No plant protection measure was taken throughout the crop season. Observations on the incidence of insect pests were recorded at weekly interval in the morning hours starting from initial appearance to final disappearance or up to final harvest. The number of nymphs and adults of sucking insect pests were recorded on three leaves, each one from the top, middle and bottom in ten randomly selected plants to express the mean number per leaf. In the case of natural enemies their number per plant was recorded. The sucking insect pests and their natural enemies associated with weeds were also recorded in the roving survey. Meteorological parameters viz., maximum temperature (^{o}C), minimum temperature (^{o}C), relative humidity (%) and rainfall (mm) during the cropping period were obtained from Meteorological Observatory, Agricultural College and Research Institute, Madurai. Correlation analysis was done to find out the relationship between the incidence of sucking pests and weather parameters, using SPSS package. Correlation coefficients were worked out as per Singh and Chaudhary (1979).

RESULTS AND DISCUSSION

The activity of the sucking insect pests and natural enemies' population in both rabi and summer crop was minimum in the weeded plot compared to the partially weeded plot.

In rabi season (Table 1), under partially weeded and weeded plots, the incidence of leafhopper commenced from 47th Meteorological Standard Week (MSW) (third week of November 2015) (1.60 nos. and 1.00 no./leaf), the aphid population occurred from 51st MSW (third week of December 2015) (5.47 nos. and 3.27 nos./leaf), and there was no whitefly incidence. With regard to age of the crop, the incidence of leafhopper and aphids commenced two and six weeks after sowing, respectively. The results are in accordance with the findings of Anitha and Nandihalli (2008), who reported that leafhopper incidence commenced from first week of December in rabi crop. The study reveals that the leafhopper population attained its maximum (6.20 nos./leaf) in 50th MSW (second week of December 2015) in partially weeded plot and it was delayed by two weeks in weeded plot (3.70 nos./leaf) i.e. 52nd MSW (fourth week of December 2015). Present investigation shows that high population of *A. gossypii* was evident during January, in rabi crop during 1st MSW (first week of January 2016) both in partially weeded (10.03 nos./leaf) and weeded plot (8.63 nos./leaf).

Anitha and Nandihalli (2008) also reported that in rabi crop, the peak incidence of leafhopper and aphids was during first week of January. Karim et al. (2001) reported that the aphid peak incidence was noticed in the months of first week of January. Rajveer et al. (2018) reported that the population of leaf hopper and whitefly on okra increased in 37th standard week and aphid incidence in 35th standard week. They added that the population of *A.biguttula biguttula*,

B.tabaci and *A. gossypii* increased with maximum temperature and bright sunshine hours. The correlation results of incidence of leafhopper and whitefly with meteorological parameters revealed that there was significant positive correlation with maximum temperature (r=0.729** and 0.857**, respectively) and minimum temperature (r=0.743** and 0.709**, respectively), in weeded plot. Similarly, partially weeded plot also recorded significant positive relationship between leafhopper, whitefly and meteorological parameters viz., maximum temperature (r=0.653** and 0.856**, respectively) and minimum temperature (r=0.711** and 0.727**, respectively) whereas, the relationship of relative humidity and rainfall with regard to all the insect pests were significantly negative, both in partially weeded and weeded plot (Table 2). In Summer crop**,** the incidence of sucking insect pests was found to be earlier than the rabi crop. In partially weeded and weeded plot, the leafhopper, whitefly and aphid occurrence started from one (0.24 and 0.28 no./leaf, respectively), two (1.82 and 1.78 nos./leaf, respectively) and three weeks (0.15 and 0.83 no./leaf, respectively) after sowing, respectively (Table 1).

The present results are in conformity with that of Laxman et al. (2014), who reported that the incidence of leafhopper and whitefly started on okra crop two

Table 1. Seasonal incidence of sucking insect pests and natural enemies on okra under weeded and partially weeded condition

		Rabi season (November 2015 – January 2016)											Summer season (March 2016- May 2016)									
		Population (No./ leaf)*						Population (No./ plant)#					Population (No./ leaf)*						Population (No./ plant)#			
DAS	MSW	Leafhopper		Aphid		Whitefly		Coccinellids		Spiders		MSW	Leafhopper		Aphid		Whitefly		Coccinellids		Spiders	
		PW	W	PW	W	PW	W	PW	W	PW	W		PW	W	PW	W	PW	W	PW	W	PW	W
7	46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9	0.24	0.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
14	47	1.60	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10	2.34	2.22	0.00	0.00	1.82	1.78	0.00	0.00	0.00	0.00
21	48	3.60	2.50	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.10	11	3.61	3.68	0.15	0.83	3.06	2.98	0.12	0.10	0.70	0.40
28	49	2.55	2.85	0.00	0.00	0.00	0.00	0.30	0.20	0.60	0.30	12	8.87	7.53	3.01	2.36	4.06	3.55	0.42	0.20	1.20	0.89
35	50	6.27	2.47	0.00	0.00	0.00	0.00	0.50	0.30	0.90	0.60	13	9.10	7.85	5.12	4.55	5.38	4.87	1.24	0.90	1.60	1.20
42	51	4.50	3.67	5.47	3.27	0.00	0.00	0.80	0.50	1.30	0.90	14	10.17	8.62	6.13	5.21	4.50	3.56	2.24	1.88	2.10	1.90
49	52	4.93	3.70	6.50	4.97	0.00	0.00	2.10	1.10	1.60	1.20	15	14.19	11.53	7.54	7.32	4.19	3.47	2.56	2.13	3.40	2.90
56	1	3.30	1.50	10.03	8.63	0.00	0.00	3.70	2.40	1.80	1.40	16	10.61	8.55	5.37	3.54	3.12	2.94	3.89	2.97	3.20	2.70
63	2	4.43	2.33	7.17	5.07	0.00	0.00	2.80	1.90	1.50	1.20	17	10.35	7.56	5.23	3.44	2.45	2.23	2.46	2.44	2.50	2.10
70	3	3.03	2.00	6.70	4.10	0.00	0.00	1.70	1.40	1.30	0.90	18	7.23	6.44	4.45	3.15	2.22	2.04	2.11	1.98	1.80	1.50
77	4	2.97	2.23	9.93	7.03	0.00	0.00	2.90	2.40	2.00	1.40	19	5.42	3.74	3.44	2.79	1.50	1.20	1.80	1.35	1.20	0.98
84	5	1.80	1.23	8.33	5.43	0.00	0.00	1.70	1.30	1.00	0.60	20	5.55	3.44	3.57	0.83	0.76	0.68	1.15	0.60	1.00	0.50

W- Weeded condition PW- Partially weeded condition MSW- Meteorological Standard Week DAS- Days after sowing *Mean of ten plants @ 3 leaves/plant

Mean of ten plants

Table 2. Correlation of insect pests and its natural enemies occurrence with weather parameters (2015-16)

Sucking insect pests and natural enemies	Mean value (2 seasons)	Maximum temperature (°C)	Minimum temperature (°C)	Relative humidity (%)	Rainfall (mm)
Weeded plot					
Leaf hopper (No./ leaf)	3.88	0.729**	0.743**	-0.496**	-0.420*
Whitefly (No./ leaf)	1.17	0.857**	0.709**	-0.573**	-0.433*
Aphid (No./ leaf)	2.90	0.032 NS	0.002 NS	-0.393*	-0.576**
Coccinellids (No./ plant)	1.03	0.278 NS	0.307*	-0.414*	-0.502**
Spider (No./ plant)	0.95	0.474**	0.495**	-0.457*	-0.487**
Partially weeded plot					
Leaf hopper (No./ leaf)	5.07	0.653**	0.711**	-0.455*	-0.436*
Whitefly (No./ leaf)	1.32	0.856**	0.727**	-0.580**	-0.431*
Aphid (No./ leaf)	3.93	0.100 NS	0.037 NS	-0.396*	-0.563**
Coccinellids (No./ plant)	1.34	0.201 NS	0.246 NS	-0.434*	-0.526**
Spider (No./ plant)	1.24	0.430*	0.456*	-0.463*	-0.520**

	Weeded plot		Partially weeded plot	
	Coccinellids	Spider	Coccinellids	Spider
Leaf hopper (No./ leaf)	0.524**	0.820**	0.534**	0.840**
Whitefly (No./ leaf	0.262NS	0.529**	0.223NS	0.514**
Aphid (No./ leaf)	0.807**	0.729**	0.834**	0.737**

n= 24; 'r' table value at 22 df: 0.344 at p= 0.05; 0.452 at p=0.01
* Significant at p= 0.05; **Significant at p=0.01; NS Non Significant

and three weeks after sowing, respectively. The finding was similar to the results of Singh et al. (2013), who reported that the incidence of aphid commenced from fourth week after sowing. The results revealed that the summer sown okra crop was more susceptible to sucking insect pests than rabi okra crop. The leafhopper occurrence started from 9th MSW (first week of March 2016), whitefly from 10th MSW (second week of March 2016) and aphid from 11th MSW (third week of March 2016) under both partially weeded and weeded plots. In partially weeded plot, the population of leafhopper and aphid reached maximum in 15th MSW (third week of April 2016) (14.19 nos. and 7.54 nos./leaf, respectively) and in weeded plot, it was 11.53 and 7.32 nos. per leaf, respectively. This finding was supported by similar results of Pal et al. (2013) and Dabhi and Koshiya (2014). While whitefly peak incidence was found two weeks earlier i.e. 13th MSW (first week of April 2016) in partially weeded and weeded plot (5.38 and 4.87 nos./ leaf, respectively). It was in line with the finding of Anitha and Nandihalli (2008), who reported that leafhopper, aphid and whitefly incidence started from first week of April, in summer crop.

Weeds are a main source for many plant feeding insect pests. When those insects are not restricted its feeding habits to the weed alone, it poses negative influence on crop protection aspect (Capinera, 2005). Weeds harbouring insect pests are harmful in the crop production. In this study, the okra crop in partially weeded plots had more sucking insects like leafhopper, whitefly and aphids. Different weed species viz., *Vemonia cinerea (L.), Parthenium hysterophorus (L.), C. rotundus (L.), A. indicum (L.)* and *Boerhaavia diffusa (L.)* were recorded in this study. It is concluded from the observation that the weeds like *A. indicum* and *P. hysteroporus* were the major weeds associated with okra ecosystem in Madurai district which harboured whiteflies and mealybug. *C. rotundus* acted as alternate host plant for leafhopper. Hence, the partially weeded plot, sustained more population of sucking insect pests than the weeded plot.

Natural enemy peak activities like spider and coccinellids (*Cheilomenes sexmaculata* and *Micraspis discolor*) were noticed during first week of January 2016 in rabi crop and during second and third week of April

2016 in summer crop. Singh et al. (2013) reported that the maximum population of coccinellids appeared in the first week of December. The outcome of this study reveals that maximum population of coccinellids was found in the eighth week of sowing both in partially weeded and weeded plot in rabi (3.70 nos. and 2.40 nos./leaf, respectively) and summer crop (3.89 nos. and 2.97 nos./leaf, respectively). It was supported by the finding that lady bird beetles population was at peak in the ninth week of sowing (Wagen and Wagen, 2015).

Natural enemy population was in accordance with the population of sucking insect pets. It was evidenced by the correlation results that coccinellids and spiders with the leafhopper were positively correlated in weeded plot (r=0.524** and 0.820**, respectively) and partially weeded plot (r=0.534** and 0.840**, respectively). Under weeded and partially weeded plot, aphids also exhibited similar significant positive relationship with coccinellids (r=0.807** and 0.834**, respectively) and spiders (r=0.729** and 0.737**, respectively). It reveals that when there was more sucking insect population, the intensity of natural enemies was also more. This finding is confirmed with the findings of Sahito et al. (2013) who reported that predator populations were increased with increase of jassid population. The findings from the Wagen and Wagen (2015) revealed that predatory spiders had significant positive correlation with sucking pests. Kumar et al. (2018) reported that rainfall, coccinellids and spider population jointly had a significant impact on *B. tabaci* population build up in okra.

Leafhopper and whitefly had significant positive relationship with the maximum and minimum temperature. All the sucking insect pests viz., leafhopper, whitefly and aphids were negatively related to relative humidity and rainfall. The result on leafhopper was supported by the finding that leafhopper population was negatively correlated with relative humidity and rainfall (Umar et al*.,* 2003). This result on aphid is in agreement with Singh et al. (2013), who reported that negative correlation of aphids was observed with relative humidity and rainfall. Kalkal et al. (2013) reported that whitefly exhibited negative correlation with rainfall. Similar studies were also reported by Shalini and Veena Maurya (2017).

Coccinellid and spider population was negatively correlated with relative humidity (r=-0.434* and -0.526**, respectively) and rainfall (r=-0.463* and -0.520**, respectively). Spider population was positively influenced by maximum and minimum temperature. The results are confirmed with the findings of Singh et al. (2013), who showed that the coccinellids had negative correlation with rainfall and maximum and minimum relative humidity.

It is concluded that the incidence of sucking pests was high in summer crop than the rabi crop, both under partially weeded and weeded plot of okra, the sucking insect pests population was significantly positively influenced by the maximum and minimum temperature, while negatively related with relative humidity and rainfall. The population of natural enemies was also higher when the population of sucking insect pests was high, it was evidenced by the significant positive correlation between them.

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