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POPULATION DYNAMICS OF MAJOR ARTHROPOD PESTS AND THEIR NATURAL ENEMIES ON OKRA

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ABSTRACT

An investigation was carried out on the population dynamics of major pests and their natural enemies on okra during *kharif,* 2016 and 2017. Results revealed that during both seasons, whitefly (*Bemisia tabaci*) and leafhopper -*Amrasaca* (*Sundapteryx*) *biguttula* occurred from the last week of July (30th Standard Meteorological Week) whereas, fruit borer (*Earias vitella*) and red spider mite (*Tetranychus cinnabarinus*) appeared in 34th and 37th SMW during 2016 and 2017, respectively. Peak population of *B. tabaci* (29.00 /15 leaves) and *A.biguttula* (179.25 /15 leaves) was observed in 32nd and 37th SMW, respectively. The peak infestation of *E. vitella* (52.43%) and *T. cinnabarinus* (247.25 /sq.cm/15 leaves) was observed in 34th SMW and 40th SMW, respectively. Incidence of *B. tabaci* showed significant negative (r= -0.786) correlation with maximum temperature and with minimum temperature (r= 0.904) and evening humidity (r= 0.766) showed significant positive correlation; *T. cinnabarinus* showed significant negative correlation (r= -0.964) with minimum temperature; and *E. vitella* having significant positive (r= 0.867) correlation with maximum temperature, while minimum temperature(r= -0.800) and evening relative humidity (r= -0.960) had significantly negative correlation. Among the natural enemies viz., coccinellids (r = 0.911), spiders (r = 0.918), rove beetles (r= 0.895), *Geocoris* bug (r= 0.672) and carabid beetles (r= 0.701) had significant positive correlation with *A. biguttula* population, whereas, coccinellids (r = -0.991) and *Geocoris* bug (r = -0.984) had significantly negative correlation with *T. cinnabarinus.*

Key words: Okra, pests, natural enemies, population dynamics, weather factors, peak incidence, correlation coefficients,

Okra, *Abelmoschus esculentus* (L.) Moench is one of the economically important malvaceous vegetable grown all over India, both in *kharif* and summer seasons. The crop is attacked by various insect pests *viz*., leafhopper *Amrasca* (*Sundapteryx*) *biguttula* (Ishida), whitefly *Bemisia tabaci* (Gennadius), shoot and fruit borer *Earias vitella* (F.), and red spider mite *Tetranychus cinnabarinus* (Boisd.) which are the major bottlenecks in achieving higher productivity of okra. For effective pest management programme, the study on the population dynamics of pests in relation to weather parameters is prerequisite (Yadav et al., 2007). Both biotic and abiotic factors together influence pest population densities, and the degree to which these factors affect natural control, varies under different situations (Hoy and Herzog, 1985). Therefore, location specific study on natural control factor is required for better understanding of biological insect pest management. Keeping this in mind, the present investigation was undertaken to investigate the seasonal abundance and diversity of major arthropod pests and beneficial fauna on okra in relation to weather parameters.

MATERIALS AND METHODS

The experiment was conducted at the research farm of Division of Entomology, IARI, New Delhi (28º38'23''N, 77º09'27''E**,** 228.61 masl) having monsoon-influenced humid subtropical climate with 25.09ºC mean annual temperature and 797.3 mm mean annual rainfall. The weekly meteorological data were obtained from Agrometeorology, Division of Agricultural Physics, IARI New Delhi. Sowing of the recommended variety of okra "*Arka Anamika*" was done in the month of July, 2016 and 2017. Required agronomic practices were followed and spacing was maintained at 60 x 45 cm between rows and plants, respectively, with the plot size of 5 x 4m. Observations on incidence of leafhopper and whitefly (per 15 leaves), red spider mite (per sq.cm area/15 leaves) on five randomly selected plants at weekly intervals while, weight of healthy and infested fruits was taken separately for recording per cent infestation due to fruit borer. Natural enemies such as spiders, big eyed bug, rove beetles and coccinellids, were also recorded by the visual count technique from the same randomly selected plants, during early hours of the day. The population of carabids was estimated by placing two pitfall traps in each plot of 20 m^2 area. Population data of different insect pests and natural enemies thus obtained were subjected to correlation analysis with weather factors.

RESULTS AND DISCUSSION

The incidence of major insect pests such as whitefly and leaf hopper on okra, was observed from early crop growth stage onwards while, infestation of fruit borer followed by red spider mite started at later crop growth period and lasted up to harvesting which also been reported earlier by (Siddartha et al., 2017). During present investigation, the activity of major sucking insect pests *viz.,* whiteflies, leafhoppers in the both crop seasons, began during last week of July (30th SMW) in the *kharif,* 2016 and 2017 (Table 1). This gradually increased until 32nd SMW and 37th SMW, respectively during both years. Similar trend of occurrence was also observed by Nagar et al. (2017) at Jobner (Rajasthan). Although, infestation of fruit and shoot borer started in the 34th SMW and population of red spider mite appeared in 37th SMW, and remained till crop maturity during both years. Similar observations on fruit borer and red spider mite were also reported by Mohanasundaram and Sharma (2011).

Study revealed that during *kharif*, 2016 and 2017, the peak activity of whitefly (28.00 and 29.00/15 leaves respectively) and leaf hopper (133.00 and 179.25/15 leaves respectively) occurred during 37th SMW. Highest fruit borer infestation (52.16 and 52.43%) was observed in 38th SMW, whereas, peak population of red spider mite (207.50 and 247.25/sq.cm/15 leaves) was recorded during *kharif* 2016 and 2017, respectively, that continued up to harvesting (Table 1). Present findings are proximal to the observations made by Mohanasundaram and Sharma, (2011); Aarwe et al, (2016); Raju et al. (2017) and Potai and Chandrakar (2018).

In the present study, occurrence of natural enemies such as coccinellids, spiders, rove beetles, *Geocoris* bug and carabids on okra were noticed from 30th SMW and lasted the observation period during *kharif* 2016 and 2017 (Table 1). Peak populations of coccinellids (6.50), spiders (6.75) per five plants and carabid beetles (0.75) per two pitfall traps was occurred in 36th SMW, whereas highest population of rove beetles (2.00) in 37th SMW and *Geocoris* bug (1.75) per five plants in the 35th SMW, were observed during *kharif*, 2016. Likewise, peak populations of coccinellids (5.75) in 37th SMW, spiders (4.50) in 36th SMW, rove beetles (1.75) in 38th SMW and *Geocoris* bug (1.25)/ five plants observed in the 35th SMW during *kharif* 2017. Present experimental results on natural enemies occurrence on okra are in line with earlier findings (Khating et al., 2016; Potai and Chandrakar, 2018; Bhatt and Karnatak, 2018).

Correlation analysis with abiotic factors revealed that whitefly population and maximum temperature had significant negative correlation (r= -0.786) during *kharif* 2016 whereas, minimum temperature showed significant positive correlation (r= 0.653, 0.904) during two years. Similarly evening relative humidity also showed significant positive correlation (r= 0.662, 0.766) during two years. Earlier, Mohanasundaram and Sharma, (2011) reported that whitefly population had significant positive correlation with minimum temperature. During both years leaf hopper population showed positive but non significant correlation with maximum temperature which has also been observed earlier (Khating et al., 2016). Fruit borer infestation had significant positive correlation with maximum temperature, whereas minimum temperature (r= -0.800) and evening relative humidity (r= -0.960) showed significant negative correlation during *kharif* 2016 which was accordance with Yadav et al. (2007) and Mohanasundarm and Sharma, (2011). Red spider mite showed significant negative correlation (r= -0.964) with minimum temperature during *kharif* 2017. Overall, impact of abiotic factors on natural enemy population was statistically non- significant in both the cropping seasons which have also been earlier observed (Singh et al., 2013).

Biotic factors play an important role in population regulation of different pests. In present study, during the two *kharif* seasons, natural enemies of major pests of okra such as coccinellids (r= 0.875, 0.911), spiders (r= 0.860, 0.918), rove beetle (r= 0.869, 0.895) and *Geocoris* bug (r= 0.638 and 0.672) had significant positive correlation with leaf hoppers but correlation with red spider mite and fruit borer was found to be significantly negative for coccinellids (r= -0.957, -0.991) and *Geocoris* bug (r= -0.983, -0.984). Present findings on effect of biotic factors (coccinellids and spiders) are similar to that of Khating et al. (2016) and Mohanasundaram and Sharma (2011). Varshney and Ballal, (2017) found close association between *Geocoris* bug and various lepidopteron eggs and mealy bugs in laboratory while Khanzada et al. (2016) observed its relationship with sucking pests of cotton in field. Moreover, carabids depressed populations of

Table 1. Population dynamics of major arthropod pests and their natural enemies on okra

kharif, 2016

SMW	Abiotic factors					Major pests (Mean Nos./15 leaves)$				Natural enemies (Mean Nos./5 plants)$				
	Max. Temp. (^{0}C)	Min. Temp. (^{0}C)	Mor. R.H. (%)	Eve. R.H. (%)	Total R.F. (mm)	WF	LH	RSM	FB#	Coccinellids	Spiders	Rove beetles	*Geocoris* sp.	Carabid beetles$^\psi$
30	34.2	25.0	92.3	75.1	61.2	11.00	26.00	0	0	0.50	1.25	0.00	0.25	0.25
31	31.5	23.6	92.0	75.7	132.1	18.00	34.75	0	0	1.25	2.25	0.50	0.25	0.25
32	31.9	25.0	88.6	72.1	71.6	28.00	43.25	0	0	2.75	3.75	0.50	0.75	0.50
33	31.7	24.3	88.1	78.3	156.0	24.75	53.25	0	0	4.00	3.00	0.75	0.75	0.25
34	33.3	24.2	87.0	71.4	23.2	20.75	62.75	0	10.19	3.75	4.00	1.00	1.00	0.50
35	33.2	23.3	94.0	77.0	269.2	18.50	76.75	0	14.26	5.25	4.75	1.75	1.75	0.50
36	33.8	23.1	84.9	61.6	5.6	17.50	104.50	0	29.34	6.50	6.75	1.25	1.50	0.75
37	34.6	23.2	80.7	53.7	0.0	14.25	133.00	94.25	44.59	5.75	5.25	2.00	1.00	0.50
38	35.6	22.2	93.6	52.4	0.0	10.25	94.25	158.50	52.16	4.50	4.50	2.00	0.75	0.25
39	33.9	21.7	89.0	52.7	0.0	8.00	54.25	190.00	46.26	4.00	3.50	0.75	0.50	0.25
40	34.8	22.9	87.9	57.9	37.8	4.25	43.75	207.50	41.69	2.75	2.25	0.50	0.50	0.25
CC: (r) for populations and maximum temp.						-0.786**	0.469	-0.138	0.867*	0.296	0.220	0.438	0.071	-0.038
CC: (r) for populations and minimum temp.						0.653*	-0.426	-0.526	-0.800*	-0.477	-0.352	-0.352	-0.120	0.117
CC: (r) for populations and morning RH						-0.086	-0.540	0.623	-0.097	-0.468	-0.441	-0.180	-0.184	-0.184
CC: (r) for populations and evening RH						0.662*	-0.549	0.436	-0.960**	-0.429	-0.369	-0.444	0.035	0.005
CC: (r) for populations and total rainfall						0.419	-0.286	0.601	-0.577	-0.105	-0.175	-0.031	0.299	-0.064

Contd.....

kharif, 2017

30	33.2	25.9	89.3	78.1	48.0	17.00	50.00	0	0	1.00	1.75	0.50	0.25	0.25
31	32.4	26.0	87.9	73.0	8.4	21.75	60.25	0	0	1.25	2.50	0.50	0.50	0.25
32	34.1	26.3	89.4	72.9	83.6	29.00	93.00	0	0	1.50	2.75	0.50	0.50	0.25
33	35.2	26.4	89.9	69.3	27.0	25.75	98.25	0	0	2.00	2.50	1.00	0.50	0.25
34	33.2	25.6	92.7	80.4	66.0	21.50	125.75	0	10.40	3.75	3.50	1.25	0.75	0.50
35	32.6	24.9	93.1	79.3	68.0	20.75	145.25	0	17.50	4.25	3.00	1.00	1.25	0.50
36	33.3	24.2	92.6	69.3	4.0	19.25	160.00	0	33.36	4.50	4.50	1.25	1.00	0.50
37	35.8	24.8	93.1	54.6	0.0	16.25	179.25	98.75	47.54	5.75	4.25	1.50	0.75	0.50
38	33.5	23.4	76.7	65.3	138.6	15.50	164.00	176.50	52.43	4.25	4.00	1.75	0.50	0.25
39	32.7	21.9	93.3	52.0	3.8	10.25	94.50	195.75	45.13	4.00	3.00	0.50	0.50	0.25
40	35.3	19.6	88.9	40.7	0.0	6.00	85.75	247.25	40.37	2.50	2.50	0.25	0.25	0.25
CC: (r) for populations and maximum temp.						-0.127	0.220	-0.273	0.455	0.135	0.113	0.127	-0.279	-0.029
CC: (r) for populations and minimum temp.						0.904**	-0.079	-0.964*	-0.508	-0.292	-0.111	-0.111	0.227	0.163
CC: (r) for populations and morning RH						0.077	-0.032	-0.165	-0.503	0.165	-0.025	-0.275	0.410	0.410
CC: (r) for populations and evening RH						0.766**	-0.074	-0.543	-0.729	-0.265	-0.122	0.192	0.380	0.255
CC: (r) for populations and total rainfall						0.326	0.213	-0.029	-0.086	-0.024	0.074	0.410	0.049	-0.109

SMW= Standard Meteorological Week; RH= Relative humidity (%); RF= Rainfall (mm); WF= Whitefly; LH= Leaf hopper; RSM= Red spider mite No./ cm^2 leaf area); [#]FB= Fruit borer % infestation; [$]= Population of pests and natural enemies means of 20 sampling units; [ψ]= Population means of two pitfall traps; CC:(r)= Correlation of coefficient; *= Significant and **= Highly significant at p=0.05 and 0.01, respectively

Table 3 Correlation matrix: Effect of biotic factors on major pests on okra during *kharif*, 2016 and 2017

Pests	Natural enemies during *kharif*, 2016					Natural enemies during *kharif*, 2017				
	Coccinellids	Spiders	Rove beetles	*Geocoris* sp.	Carabid beetles	Coccinellids	Spiders	Rove beetles	*Geocoris* sp.	Carabid beetles
Whitefly	0.085	0.212	-0.032	0.317	0.422	-0.304	-0.052	0.152	0.292	0.119
Leaf hopper	0.875**	0.860**	0.895**	0.638*	0.569	0.911**	0.918**	0.869**	0.672*	0.701*
Red spider mite	-0.957*	-0.925	-0.850	-0.983*	-0.914	-0.991**	-0.904	-0.747	-0.984*	-0.875
Fruit borer	-0.100	-0.180	0.095	-0.669	-0.570	0.206	0.209	0.070	-0.584	-0.633

*= Significant; **= highly significant at p=0.05 and 0.01, respectively

cicadellidae and thysanoptera in maize (Lang et al., 1999). Manley, (1997) also found that rove beetles were able to reduce population of sucking as well as lepidopteron pests in rice field.

It can be summarised that in the pest population regulation, both abiotic and biotic factors play a pivotal role. With this information need based application of pesticides in IPM of vegetables can be advocated.

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