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DIVERSITY OF ARTHROPODS IN RELATION TO INSECTICIDE AND BIOPESTICIDE TREATMENTS IN OKRA

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ABSTRACT

Present study was carried out during 2019 at the Vegetable Research Farm, Punjab Agricultural University, Ludhiana to generate information on diversity of invertebrates in okra. Study revealed that okra crop was harboured by 27 invertebrate species belonging to 11 orders and 26 families. Of these, maximum belonged to order Hemiptera followed by Coleoptera. Higher values of Shannon-Wiener index (1.75, 1.84) and Simpson's index (0.26, 0.17), respectively were recorded for both phytophagous arthropods and predators in untreated control plots. This is followed by neem/ other insecticides treated plots. Imidacloprid lowered the arthropod population. Occurrence of predators and phytophagous arthropods revealed a significant positive correlation with temperature (r=+0.37 to +0.99) and relative humidity (r=+0.04 to +0.80) except for few hemipterans and coleopterans.

Key words: Okra, arthropods, insects, diversity, biopesticide, insecticides, neem, phytophagous, predators, Diversity indices, population dynamics, weather factors

Biodiversity refers to the number and variety of living organisms that live in a particular area or across the world, and provides economic benefits and ecological stability (Iqbal et al., 2018). Okra (*Abelmoschus esculentus* L.) is an important vegetable crop infested by a large variety of arthropods. It plays a vital role in the human diet (Adeboye and Opunta, 1996; Baloch *et al.*, 1990). Low yield of okra is due to damage caused by many arthropods (Rachana et al., 2009) and species diversity of arthropods varies from region to region. About, 72 arthropods infest okra crop (Rao and Rajendran, 2002), however, those causing economic loss include whitefly, shoot and fruit borer and thrips (Solangi and Lohar, 2007). Some others like red cotton bug are of minor importance (Dhamdhere et al., 1984); green semilopper, cotton stem weevil and pink bollworm. Borer and sucking arthropods are the major constraints; 91.60% loss is caused by *Earias* spp. and *Helicoverpa armigera* (Hubn.) (Pareek and Bhargava, 2003); 48.97% damage was reported due to insect pests (Kanwar and Ameta, 2007); 74.00% loss due to damage by sucking arthropods is known, of which, about 40.00% was due to leafhoppers (Rawat and Sahu, 1973). Among sucking arthropods whitefly is the major problem as a vector of leaf curl virus and causing 54.00% reduction in yield (Rai et al., 2014); spider mite caused 17.46% reduction in yield and it is a major pest (Mandal et al., 2006). Besides these, cotton aphid, red cotton bud and blister beetle were also reported (Barwal and Rao, 1988).

In okra crop, population of phytophagous arthropods and non arthropods have been influenced by weather parameters such as temperature and relative humidity. The abundance and rate of built up of these can be understood by study of their interaction with weather factors (Khan et al., 2001). Injudicious use of pesticides had resulted in development of resistance to pesticides and also have adverse effects on predators, resurgence of minor arthropods, environmental pollution, hazards to economy and health (Mandal et al*.,* 2006). Although, the use of pesticides cannot be avoided, yet their use can be limited by including biopesticides. Different neem extracts have been reported as ecofriendly option in okra (Bindu et al., 2003). Neem formulations have no toxic effects and are least toxic to non target organisms and have very less chances of development of resistance as these act as growth inhibitor, oviposition deterrent and antifeedant (Patel et al., 1996). However, information is scanty regarding invertebrates/ arthropods present in okra. Hence, this study to have a more detailed and consolidated account of invertebrates/ arthropods present on okra crop field under both sprayed and unsprayed conditions.

MATERIALS AND METHODS

The present surveys were carried out at the Vegetable Farm, PAU, Ludhiana from July to December 2019 on okra (variety Punjab Suhawani). The field was levelled and was divided into plots of size (3 x 4 m) as per layout in RBD design. Sowing was done on 2th July, 2019 with a recommended row to row 45 cm and plant to plant 30 cm distance. Recommended agronomic practices were followed. Insecticides evaluated include- flonicamid 50%WP @ 0.8 g/ l of water (ulala), imidacloprid 200SL @ 0.4 ml/ l of water (Confidor), spiromesifen 240SC @ 1.5 ml/ l of water (Oberon); and biopesticide neem bhan (50,000 ppm) @ 0.8 ml/ l of water (azadirachtin 5%EC). Treatments were allocated to plots on random basis, with sprays done duing 2nd week of August and 1st week of September, with knapsack sprayer. For counts of invertebrates visiting okra, five plants/ plot were selected randomly (belonging to four sides as well as from the centre of field) and from each plant three leaves were randomly selected each from upper, middle and lower leaves (nine leaves/ plant). The counts were made at weekly intervals from germination till harvest, with invertebrates searched visually and collected by using aspirator, sweep net, pitfall method and pheromone trap. Sweep net method was used to count the abundance of flying insects for which sweeping was done back and forth through the plant canopy five times in each plot (Newman, 1835). Specimens collected were sorted, counted, photographed and identified using suitable keys. The collected invertebrates were killed with ethyl acetate. Large invertebrates were pinned and preserved in insect collection box, whereas small invertebrates were preserved in 70% alcohol. Weather data was obtained from the meteorological observatory (Department of Climate Change and Agricultural Meteorology, Punjab Agricultural University, Ludhiana). Occurrence of invertebrates was correlated with temperature and relative humidity. To calculate biodiversity indices like relative abundance, Simpson index, Shannon- Wiener Index and species evenness standard formulae were followed.

The mean values of occurrence of arthropods and non arthropods were calculated and correlated with temperature and relative humidity using correlation regression analysis. Data was analysed using one way of ANOVA to record the efficacy of treatments along with control. Comparison was made between different treatments using Tukey's test.

RESULTS AND DISCUSSION

As regards, diversity of phytophagous invertebrates The results from the weekly surveys revealed the occurrence of 27 species belonging to 11 orders and 26 families (Table 1); Hemiptera with maximum species (eight) followed by Coleoptera (six). Hemipterans recorded were jassids, whitefly, coreid bug, mealy bug, dusky cotton bug, red cotton bug, sugarcane leaf hopper, stink bug among which whitefly and jassid were predominant. Lepidoptera found on okra were okra fruit and shoot borer, tobacco cutworm, and American bollworm, and Coleoptera include- red pumpkin beetle, blister beetle, ash weevil, white spotted leaf beetle and chafer beetle. Among predators, lady bird beetle, dragonfly, damselfly, rober fly, yellow wasp, spider, and praying mantid were found. Nair et al. (2017) in okra from Tripura, India revealed Hemiptera as the most abundant group followed by Coleoptera. Bhatt et al. (2018) also found Hemiptera as the most abundant at Pantnagar (Uttarakhand). Ruhul Amin et al. (2019) reported that Hemiptera was most abundant in Gazipur (Bangladesh).

Diversity indices revealed higher value of species richness (19.00) for phytophagous arthropods in untreated control plots; and flonicamid, imidacloprid and neem baan treated ones. The value of evenness recorded was 0.59, 0.58, 0.56, 0.55 and 0.54 for control, neem baan, spiromesifen, flonicamid and imidacloprid treated okra plots. This indicates a decrease in trend of evenness in phytophagous arthropods. The Shannon–Wiener index (H') for the phytophagous arthropods was 1.75, 1.60, 1.67, 1.59 and 1.71 for control, spiromesifen, flonicamid, imidacloprid and neem baan treated plots, respectively. The data indicates that control and neem baan treated okra fields diverse followed by spiromesifen treated fields whereas, fields treated with flonicamid and imidaclopr d were less diverse as compared to control. The Simpson's index (D) for control, spiromesifen, flonicamid, imidacloprid and neem baan treated plots was recorded to be 0.26, 0.30, 0.28, 0.33 and 0.27, respectively indicating high degree of diversity in control and neem baan treated plots. The value of evenness for predators was 0.88, 0.85, 0.78, 0.75 and 0.75 for control, neem baan, spiromesifen, flonicamid and imidacloprid treated okra fields, respectively which indicate a decrease in trend of evenness; Shannon–Wiener index (H') was 1.85, 1.63, 1.53, 1.57 and 1.76 for control, spiromesifen, flonicamid, imidacloprid and neem baan treated fields, respectively. The data indicates that control and neem baan treated fields were more diverse followed by spiromesifen treated fields whereas, fields treated with flonicamid and imidacloprid were less diverse as compared to control. The Simpson's index (D) for control, spiromesifen, flonicamid, imidacloprid and neem baan fields was 0.17, 0.21, 0.23, 0.23 and 0.29, respectively indicating high degree of diversity (Table 1).

Table 1. Diversity, richness and evenness under sprayed and unsprayed conditions in okra

Order	Species	Occurrence				
		Control	Spiromesifen	Flonicamid	Imidacloprid	Neem baan
		Phytophagous arthropods				
Coleoptera	Ash weevil	0.78	0.12	0.06	0.06	0.18
	Red pumpkin beetle	1.09	0.06	0.06	0.12	0.12
	Blister beetle	1.56	0.82	0.62	0.31	0.70
	Chafer beetle	3.90	0.70	0.38	0.24	1.77
	White spotted leaf beetle	0.96	0.12	0.18	0.06	0.18
Hemiptera	Stink bug	2.75	0.63	0.57	0.76	1.09
	Whitefly	94.07	4.67	3.58	3.70	8.50
	Jassid	131.87	37.88	20.21	30.81	46.42
	Red cotton bug	2.77	1.23	0.85	1.11	1.87
	Dusky cotton bug	2.84	1.18	0.91	0.97	1.44
	Mealy bug	2.12	0	0.46	1.46	0.66
	Sugarcane leafhopper	0.51	0.06	0.12	0.06	0.12
	Rice stem borer	0.59	0.18	0.06	0.06	0.26
	Coreid bug	1.23	0.13	0.06	0.12	0.19
Lepidoptera	Okra fruit and shoot borer	7.83	2.12	1.97	1.63	2.80
	American bollworm	13.23	4.36	2.58	4.03	5.63
Trombidiformes	Red spider mite	49.03	11.68	20.9	26.96	19.88
Stylommatophora	Snail	6.21	3.87	3.57	2.90	4.28
Orthoptera	Grasshopper	3.10	0.06	0.06	0.13	1.17
Species richness		19.00	18.00	19.00	19.00	19.00
Species evenness		0.59	0.56	0.55	0.54	0.58
Simpson's index		0.26	0.30	0.28	0.33	0.27
Shannon-Wiener index		1.75	1.60	1.67	1.59	1.71
		Predators				
Coleoptera	Lady bird beetle	5.95	2.48	2.15	2.10	5.26
Araneae	Spider	4.62	2.76	2.62	1.95	4.08
Hymenoptera	Yellow wasp	1.09	0.38	0.18	0.12	0.75
Diptera	Robber fly	1.10	0.12	0.12	0.06	0.63
Odonata	Dragonfly	4.36	2.49	2.16	1.56	3.51
	Damselfly	4.22	2.69	2.23	1.63	3.62
Orthoptera	Silent leaf runner	2.10	0.19	0.06	0.06	1.10
Dictyoptera	Praying mantid	0.31	0.06	0.06	0.06	0.25
Species richness		8.00	8.00	8.00	8.00	8.00
Species evenness		0.88	0.78	0.75	0.75	0.85
Simpson's index		0.17	0.21	0.22	0.23	0.19
Shannon-Wiener index		1.84	1.63	1.57	1.57	1.76

The occurrence of phytophagous arthropods was observed to be in a non-significant positive or negative correlation with relative humidity as given in Table 2; Purohit et al. (2006) reported a positive correlation with jassids, while Ghuge et al. (2020) with evening relative humidity showed a non-significant positive correlation with whitefly at Parbhani (Maharashtra); Gupta et al. (1998) and Ghuge et al. (2020) observed a positive correlation of fruit and shoot borer with relative humidity. Mandal et al. (2006) reported such a positive correlation of red spider mite. Ghuge et al. (2020) reported that *H. armigera* was exhibiting a a non-significant positive correlation. As far as temperature is concerned, there was a non-significant negative correlation (r=-0.03 to -0.82) with many arthropods. Jat and Singh (2019) revealed that there was a negative correlation with maximum temperature for jassids in Rajasthan; Khating et al. (2016) reported a negative correlation with minimum temperature. With predators mean relative humidity showed a non-significant positive correlation (r= +0.06 to +0.74) as shown earlier (Singh et al., 2020; Nayer et al., 2017; Shukla et al., 2014; Dhaka and Pareek, 2007). For predators, it was a non-significant negative correlation with mean temperature for some, however, it was r=+0.88 to +0.99 for dragonfly, damselfly and silent leaf runner, and

Table 2. Correlation coefficients- phytophagous arthropods and predators in okra vs RH and Temperature

Species	Mean incidence/ occurrence				RH Correlation coefficient (r)	Temperature Correlation coefficient (r)
	July	Aug	Sept	Oct		
Blister beetle	0.01	0.23	0.13	0.01	+0.69	+0.57
Chafer beetle	0.03	0.47	0.46	0	+0.80	+0.60
White spotted leaf beetle	0	0	0.19	0.04	+0.26	-0.03
Stink bug	0	0.09	0.48	0.11	+0.37	+0.06
Whitefly	0.73	11.66	9.53	1.66	+0.71	+0.51
Jassid	0.43	9.21	15.53	7.79	+0.30	-0.03
Red cotton bug	0	0.13	0.38	0.18	+0.19	-0.13
Dusky cotton bug	0	0	0.34	0.21	-0.15	-0.41
Mealy bug	0	0	0.34	0.18	-0.03	-0.33
Coreid bug	0	0.09	0.19	0.01	+0.66	+0.37
Okra fruit and shoot borer	0	0.84	1.06	0.04	+0.74	+0.49
American bollworm	0.01	1.71	1.48	0.09	+0.74	+0.53
Red spider mite	1.76	6.73	3.06	0.69	+0.70	+0.67
Snail	0.03	0.83	0.63	0.06	+0.73	+0.59
Grasshopper	0	0.44	0.28	0.04	+0.65	+0.49
Red pumpkin beetle	0	0.03	0.80	0.06	+0.24	-0.80
Ash weevil	0	0	0.08	0.11	-0.59	-0.82
Sugarcane leafhopper	0	0.03	0.09	0	+0.65	+0.37
Rice stem borer	0	0	0	0.14	-0.96*	-0.98*

Predators vs relative humidity

Species	Mean occurrence				Correlation coefficient (r)
	July	Aug	Sept	Oct	
Lady bird beetle	0.08	0.58	0.64	0.18	+0.06
Spider	0.03	0.48	0.54	0.09	+0.72
Yellow wasp	0.03	0.14	0.06	0.03	+0.71
Robber fly	0	0	0.19	0.08	+0.04
Dragonfly	0.03	0.54	0.44	0.06	+0.74
Damselfly	0	0.41	0.53	0.11	+0.64
Silent leaf runner	0	0.21	0.26	0.04	+0.69
Praying mantid	0	0.03	0.03	0.01	+0.60

*Significant at p=0.05

Predators vs temperature

Species	Mean occurrence				Correlation coefficient (r)
	July	Aug	Sept	Oct	
Lady bird beetle	0.08	0.58	0.64	0.18	+0.99**
Spider	0.03	0.48	0.54	0.09	+0.95*
Yellow wasp	0.03	0.14	0.06	0.03	+0.93*
Robber fly	0	0	0.19	0.08	-0.07
Dragonfly	0.03	0.54	0.44	0.06	+0.99*
Damselfly	0	0.41	0.53	0.11	+0.90*
Silent leaf runner	0	0.21	0.26	0.04	+0.92*
Praying mantid	0	0.03	0.03	0.01	+0.88

significant. Similar results were obtained by Dwivedi et al. (2018), Nager et al. (2017), Mouly et al. (2018), Patel et al. (2005), Dhaka and Pareek (2007) and Bhatt et al. (2018).

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AUTHOR CONTRIBUTION STATEMENT

All authors equally contributed.

CONFLICT OF INTEREST

No conflict of interest.

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