Original Research Article

Influence of abiotic factors on population of aphid complex and its coexisting natural enemies in mustard agroecosystem

ABSTRACT

A field experiment was conducted to determine the population build-up of mustard aphid and their natural enemies in relation to abiotic factors at TCA, Dholi during the *Rabi* season of 2018-19 and 2019-20, respectively. The incidence of mustard aphid started in the 2nd and 3rd SMW of 2019 and 2020, respectively and reached maximum in 8th SMW in both the years. However, the predatory activity of coccinellids, syrphid larvae and spiders were started from 3rd SW with their peak activity at 3rd and 4th week of February in both the years. Mustard aphid population exhibited positive correlation with maximum temperature (0.347 & 0.543), minimum temperature (0.317 & 0.152) and negative correlation with relative humidity (-0.083 & -0.479) during 2019 & 2020, respectively and rainfall (-0.35) during 2020. However, natural enemies *viz.*, coccinellids, syrphid larvae and spiders exhibited positive correlation with Tmax, Tmin, rainfall and negative correlation with RH in both the years.

Key words: Mustard aphid, natural enemies, abiotic factors, correlation

1. INTRODUCTION

Mustard is the 2nd most important edible oil seeds in India after groundnut and accounts for nearly 30% of the total oil seeds produced in the country... It has multifaceted uses *i.e.*, seed as a condiment, edible oil, leafy vegetables, oil cake and also have immense nutritive value. It is the most important edible oil in North India and it would be difficult to replace it with any other oil seed crop. However, the production of mustard is hindering due to various abiotic and biotic factors. Among biotic factors, mustard aphid (*Lipaphyis erysimi* group, *Myzus persicae* and *Brevicoryne brassicae*) a potentially serious Key pest of mustard crop has still been taking away of heavy loss of production. This noxious pest is responsible to inflict 27 to 96 % yield loss in mustard in India (Bakhetia and Sidhu, 1983). The knowledge on the biology of pest is very important because it is influenced by interaction among individuals of the species, their habitats and the surrounding environment including the climatic regime. The study of relationship between insects and its environment provides basic information about the population density and pest management measures to be undertaken for effective management with regard to the population levels (Croft and Hoyt, 1983). Monitoring of pest population and measuring the abundance of natural enemies relatively is important in any pest control programme to determine the spray schedule of insecticides and to reduce the problem of pesticide residues (Sarwar, 2009). Abiotic factors including temperature, relative humidity, rainfall and sunshine have a significant influence on the population of insect pests (Agarwal et al., 1999).

2. MATERIALS AND METHODS

The present investigation was conducted during 2019-20 & 2020-21 in the Experimental Farm of the Department of Entomology, TCA Dholi, Bihar, India (25°59'10.7" N latitude and 85°40'51.5" E longitude). For this purpose, mustard variety yellow sarson (66-197-3) was raised in an area of 420 m^2 following the recommended package of practices except crop protection measures for the survey and investigation. Observations on population of mustard aphid and its natural enemies were recorded at weekly intervals under natural field conditions on twenty randomly tagged plants between 09:00 to

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16:00 h when sunny to mostly sunny (Kieckhefer *et al*., 1992). The population of mustard aphid was recorded from top 10 to 15 cm portion of the terminal shoot and for natural enemies whole plant visual inspection for at least 15 minutes were carried out (Patel et al., 2004).The observations were taken from the initial appearance of the mustard aphid and its natural enemies to their final disappearance. Relation between mustard aphid and their natural enemies and different weather parameters were worked out by Pearson correlation coefficient, regression and PCA. Data on different weather parameters [maximum and minimum temperatures (˚C), morning and evening relative humidity (%) and total rainfall (mm)] were obtained from nearby Agrometeorological observatory. Data were pooled for both seasons and Correlation and regression analysis were done with IBM SPSS and PCA was plotted by R software.

3. RESULTS AND DISCUSSION

3.1 Mustard aphid complex

The infestation of mustard aphid complex was started from 3rd Standard Week (SW) and 2nd SW during 2018-19 and 2019-20, respectively (Tables 1-2). Maximum population of 125.37 and 115.64 aphids/ top 10 cm central shoot was observed on 8th SW in both the years respectively. Thereafter gradual decline in the population of aphid was evident. Severity of mustard aphid complex was higher during 2018-2019 as compared to the year 2019-2020. The present observations on seasonal incidence of mustard aphid complex are in partial conformity with the findings of earlier workers done by Panda et al. (2000), Maji et al. (2020) who also found that aphid population reaches its peak in the middle of February when crop was 75 day's old and after that it started decline. Aphid population was positively correlated with maximum temperature (0.347 & 0.543), minimum temperature (0.317 & 0.152) and negative correlation with relative humidity (-0.083 & -0.479) during 2019 & 2020 respectively and rainfall (-0.35) during 2020 (Table 3). These results are in accordance with the results of Hasan et al. (2009); Abbas et al. (2014), who reported that the aphid population was noticed to be positively governed by temperature. Whereas, relative humidity and rainfall had shown negative effect.

3.2 Natural enemies

Natural enemies play a crucial role in influencing the mustard aphid population in relation to abiotic factors. Coccinellids, syrphid larvae and spiders are the dominant predators in mustard ecosystem in both the years. Monitoring of abundance of natural enemies is an important component of are wide pest control which overcome the usage of insecticides.

3.2.1 Coccinellids

Coccinellids are the potential predator of mustard aphid. Initially, the coccinellid population was low but increased sustainably with an increase in the aphid population. Incidence of ladybird beetles were started from 4th SW in both the years with a population of 0.55 and 0.95/plant, respectively (Tables 1-2). The population of coccinellids reached at its peak of 5.48 and 4.89/ plant in 8th SW of both the years. Afterwards, coccinellids populations decreased gradually due to a reduction in prey density. Coccinellid population was positively correlated with Tmax (0.379 & 0.579), Tmin (0.382 & 0.226), rainfall (0.033) and negatively correlated with RH (-0.091 & -0.437) (Table 3). The results are in line with the findings of Dwivedi et al. (2018).

3.2.2 Syrphid Larvae

Syrphid larvae are important predators in mustard crop and actively feed on nymphs and adults of aphids. The population of the syrphid larvae started from 3rd SW in both the years with a population of 0.48 and 0.36/plant (Tables 1-2). The population of the syrphid fly reached at its peak of 4.35 and 3.54/plant in 8th SW during both the years. Similar results were reported by Vekaria and Patel (1999), Kulkarni and Patel (2001). Syrphid larvae population was positively correlated with Tmax (0.354 & 0.586), Tmin (0.333 & 0.171), rainfall (0.155) and negatively correlated with RH (-0.070 & -0.552) (Table 3). The results are in line with the findings of Dwivedi et al. (2018).

3.2.3 Spiders

Spiders are generalist predators which largely feed on sucking pests such as aphids as well as various lepidopteran pests recorded in the mustard ecosystem. Spiders were present during the entire crop period starting from January to March. The population of the spiders started from 4th and 3rd SW in 2019 and 2020 respectively, with a population of 0.25 and 0.31/plant. The population of the spiders reached at its peak of 4.35 and 3.54/plant in 8th SW during both the years. Literature concerning population dynamics of spiders in mustard crop is scarce. However, Subba (2013) observed the peak spider population during February and March in tomato crop. It showed a positive correlation with Tmax (0.536 & 0.599), Tmin (0.589 & 0.337), rainfall (0.053) and negatively correlated with RH (-0.277 & -0.340) (Table 3). In contrast, a positive correlation with temperature and sunshine hours; negative correlation with relative humidity has been reported (Patel et al., 2005; Subba 2013).

Table 1: Population dynamics of aphid complex and coexisting predators on mustard during *Rabi*, 2018-19

Month	SMW	Mean no. of mustard aphid	Mean no. of coccinellids	Mean no. of Syrphid larvae	Mean no. of spiders	Tmax (ºC)	Tmin (ºC)	RH (%)	Rainfall (mm)
January	1	0	0	0	0	13.9	6.9	86	0
	2	0	0	0	0	12.8	6.3	88.5	0
	3	3.45	0	0	0.25	15.2	8.3	86	0
	4	9.51	0.55	0.48	0.58	20	8.5	82	0
	5	45.24	1.98	1.21	1.22	21.8	9.9	79.5	0
February	6	98.12	3.21	2.84	1.94	24.9	10.2	75.5	0
	7	110.1	3.74	3.12	2.42	24.3	11.5	80	0
	8	125.37	5.48	4.35	3.74	28.2	13.1	78	0
	9	91.43	4.42	3.02	3.62	29.1	16.1	75.5	0
March	10	34.35	1.25	0.78	2.55	30.6	14.6	67	0
	11	12.03	0.64	0.46	1.31	31.6	16.5	70	0
	12	0	0	0	0	34	14.8	62.5	0

Table 2: Population dynamics of aphid complex and coexisting predators on mustard during *Rabi*, 2019-20

Month	SMW	Mean no. of mustard aphid	Mean no. of coccinellids	Mean no. of Syrphid larvae	Mean no. of spiders	Tmax (ºC)	Tmin (ºC)	RH (%)	Rainfall (mm)
January	1	0	0	0	0.31	15.7	5.9	83	0
	2	6.32	0	0	0.55	19.1	9.3	83.5	0
	3	11.55	0	0	0.65	17.1	8.7	88.5	1.8

	4	38.66	0.95	0.36	1.01	19.9	10.9	84.5	4.4
	5	20.41	1.63	0.98	1.11	20.8	7.6	76	0
February	6	63.01	2.01	1.78	1.48	22.7	9.5	80	0
	7	95.34	2.71	3.03	2.11	23.3	8.8	71.5	0
	8	115.64	4.89	3.54	2.41	25	10.9	77	0
	9	48.89	2.62	2.51	2.01	26.5	13.5	82.5	24
March	10	32.34	4.24	2.12	3.84	26.6	13.9	79.5	0
	11	15.98	1.05	0.85	1.06	27.1	15.7	79	8.2
	12	4.81	0.21	0.35	0.63	26.7	15.3	75	4.4

Table 3: Pearson correlation coefficient of aphid complex and coexisting predators with weather parameters (2019-20)

Year	Weather parameters	Mustard aphid	Coccinellids	Syrphid larvae	Spiders
2018	Tmax	0.347	0.379	0.354	0.536
	Tmin	0.317	0.382	0.333	0.589*
	RH	-0.083	-0.091	-0.070	-0.277
	Rainfall	-	-	-	-
2019	Tmax	0.543	0.579*	0.586*	0.599*
	Tmin	0.152	0.226	0.171	0.337
	RH	-0.458	-0.437	-0.552	-0.340
	Rainfall	-0.35	0.033	0.155	0.053

*= Significant at $P = 0.05$

4. CONCLUSION

The population of mustard aphid complex has a positive correlation with maximum and minimum temperature and negative correlation with relative humidity and rainfall. Furthermore, the population of predators viz., coccinellids, syrphid larvae and spiders exhibit a positive correlation with temperature and rainfall and negative correlation with relative humidity. Thorough knowledge of population dynamic studies of mustard aphid complex and its natural enemies in relation to biotic factors may strengthen the development of efficient pest management strategies. A holistic IPM program can be designed against aphid complex in mustard where predators can be used in conjugation with other control strategies. This may reduce the dependence on pesticides and may reduce the problems associated with indiscriminate pesticide usage.

COMPETING INTERESTS DISCLAIMER:

Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the

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