

Original Research Article

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Seasonal Abundance of Rice Leaf Folder and its Natural Enemies in Irrigated Rice Ecosystem

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ABSTRACT

Keywords

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A field experiment on seasonal abundance of rice leaf folder and its natural enemies under irrigated condition was carried out on farmer's fields in villages (Murchipur, Shivdaspur and Dabhasemar) of District- Faizabad (U.P). The incidence of leaf folder was relatively more in *Kharif*, 2013 as compared to *Kharif*, 2014. The maximum population and damage of leaf folder was recorded in village Dabhasemar followed by Shivdaspur. The predators i.e. spiders, coccinellids, ground beetles, earwigs, dragonflies and damselflies were dominant in both *Kharif* seasons. Highest population of spiders, coccinellids, and the ground beetles per 5 hills and per five sweeps was recorded at 75 to 90 days after transplanting, while the maximum population of earwigs, dragonflies and damselflies were recorded at 60 to 75 days after transplanting. Among parasitoids the *Apanteles sp.*, *Itopectic sp.*, *Xanthopimpla sp.* and *Trichogramma sp.* were dominating. However, the maximum population of parasitoids was recorded between 75 to 90 days after transplanting.

Introduction

India has the world's largest area under Rice (*Oryza sativa* L.) with 44.1 million ha and is the second largest producers 105.48 million tons in 2014-15, next to China (Anonymous, 2016). Rice is a high energy food and play vital role in national food security. Rice contains high carbohydrates 77.84 per cent and low fat about 2.0 to 2.5 per cent. It is a good source of thiamine, riboflavin and niacin including eight essential amino acids (Prakash *et al.*, 2007). Among the various insect-pests damaging the rice crop stem borer, gall midge, brown plant hopper and leaf folder are major pest in India (Anonymous, 2003).

Insect-pests damage rice crop at different stages of crop growth of which leaf feeding insect Rice leaf folder, *Cnaphalocrocis medinalis* (Guenee) is of major importance because of its ability to remove the chlorophyll content of the leaves results considerable reduction in yield.

The yield loss was recorded from 30-80 per cent due to leaf folder epidemic situation (Rani *et al.*, 2007). Among the natural enemies of paddy viz. spider, dragonfly (*Crocothemis sp.*), damselfly (*Agriocnemis sp.*), predatory cricket, rove beetle (*Paederu*

fuscipes), ground beetle (*Ophionea indica* and *Casnoidea indica*), predatory grass hopper (*Conocephalus* sp.) and brown bug (*Andrallus spinidens*) were major one in rice ecosystem (Tiwari *et al.*, 2001).

Materials and Methods

The survey was carried out to know the status of the leaf folder and their natural enemies *i.e.* predators and parasitoids under irrigated condition at various crop stages *viz.*, maximum tillering, panicle initiation, flowering and dough stage of crop at farmers' fields in surrounding villages of Crop Research Station, Masodha (NDUAT), Faizabad *viz.*, Murchipur, Shivdaspur and Dabhasemar during two consecutive *Kharif* seasons of 2013 and 2014.

Observations

Leaf folder damages and the population of various natural enemies on farmers' fields were recorded on 10 randomly selected hills with standard method adopted SES scale provided IRRI (1996). The population of adult moth of leaf folder and their natural enemies were recorded by five sweeps with insect collecting hand net at 5 places in rice field. Leaf folder damaged leaves were recorded based on total no. of leaves and damaged leaves (1/3 part folded)/5 hill. The data recorded thirty days after transplanting and up to fifteen days before harvesting at fortnight intervals.

Determination of correlation coefficients

The data on weather factors such as temperature and rainfall of the crop season during *Kharif*, 2013 and 2014 were obtained from the C.R.S. Masodha, Faizabad (U.P.) to correlate the occurrence of leaf folder and its natural enemies with weather factors. The data recorded on the occurrence on insect-

pests were statistically analyzed in order to determine the correlation coefficients between occurrence of leaf folder and its natural enemies and weather factors.

$$r = \frac{\sum xy - \frac{\sum(x) \sum y}{N}}{\left(\sum x^2 - \frac{\sum(x)^2}{N} \right) \left(\sum y^2 - \frac{\sum(y)^2}{N} \right)}$$

Results and Discussion

Leaf folder incidence under irrigated condition

The leaf folder and its natural enemies complex were prominent at farmer's fields of surrounding villages of Crop Research Station, Masodha, during *Kharif* 2013 and 2014 (Tables 1 and 2). The maximum population and damage of leaf folder was recorded in village Dabhasemar followed by Shivdaspur and Murchipur.

Murchipur

The maximum incidence of leaf folder as damaged leaves and adult population were recorded at 105 DAT and minimum at 30 DAT *i.e.* 10.94 per cent and 22.00 adults per five sweeps and 0.42 per cent and 11.80 adults per five sweeps respectively during *Kharif*, 2013.

During *Kharif*, 2014 the highest damaged leaves and population of leaf folder were recorded at 105 DAT and minimum at 30 DAT *i.e.* 9.02 per cent and 19.00 adults per five sweeps and 0.75 per cent and 6.60 adults per five sweeps respectively.

Shivdaspur

The incidence of leaf folder revealed that the per cent damaged leaves and population were

highest at 105 DAT *i.e.* 19.49 per cent and 30.40 adults per five sweeps at 75 DAT respectively. The lowest damage and adult population recorded at 30 DAT *i.e.* 0.47 per cent and 8.20 adults per five sweeps respectively during *Kharif*, 2013.

However, during *Kharif*, 2014 the maximum damaged leaves and population were observed at 105 DAT with 18.92 per cent and 33.40 adults per five sweep 90 DAT respectively and minimum at 30 DAT *i.e.* 0.65 per cent and 8.20 adults per five sweeps respectively.

Dabhasemar

Damaged leaves by leaf folder and population were observed maximum at 105 DAT *i.e.* 21.03 and 28.20 adults and minimum at 30 DAT *i.e.* 1.23 per cent and, 7.40 adults per five sweeps respectively during *Kharif*, 2013.

However during *Kharif*, 2014 leaf folder damage and population was recorded minimum at 30 DAT *i.e.* 1.28 per cent and 12.20 adults per five sweeps and maximum was found 22.91 at 90 DAT and 34.00 adults per five sweeps respectively. Similar results were also observed by Bhattacharya *et al.*, (2006); and Khan *et al.*, (2004), which support present findings.

Natural enemies' complex

Among natural enemies, the highest population of spiders, coccinellids and ground beetles per 5 hills and per five sweeps was recorded at 75 to 90 days after transplanting, while the maximum population of earwigs, dragonflies and damselflies were recorded at 60 to 75 days after transplanting. The important parasitoids recorded during both the year were *Apanteles sp.*, *Itopectic sp.*, *Xanthopimpla sp.* and *Trichogramma sp.* However, the maximum population of parasitoids was recorded between 75 to 90

days after transplanting (Tables 1 and 2).

Murchipur

Spiders

The spider *viz.*, wolf spiders, long jawed spiders, orb spiders and lynx spiders and others were noticed throughout the cropping period starting from transplanting to harvest.

The highest population recorded at 75 DAT with 23.60 per five hill and 12.00 per five sweeps, minimum at 30 DAT 4.40 per five hills 2.60 per five sweeps during *Kharif*, 2013. However, *Kharif*, 2014 maximum population was recorded 22.40 per 5 hill and 10.20 per five sweeps while minimum at 30 DAS 2.60/ 5hill and 3.10/ five sweeps, respectively.

Coccinellids

Data presented in (Tables 1 and 2) showed that the per hill coccinellids population was highest with 8.40 at 75 DAT, 7.60 at 90 DAT per 5 hill and 9.40, 7.60 adults per five sweeps in during *Kharif*, 2013 and 2014 respectively. The minimum population was found at 30 DAT with 2.80, 1.90 per 5 hill and 2.60, 1.60 adults per five sweeps during *Kharif*, 2013 and 2014 respectively.

Dragonflies

Dragonfly population was highest at 60 DAT with 16.20 and 10.60 per five sweeps and minimum at 105 DAT with 4.60 and 2.40 90 DAT per five sweeps during *Kharif*, 2013 and 2014 respectively.

Ear wig

The earwig showed maximum population at 60 DAT with 5.00 during *Kharif*, 2013 and at 90 DAT with 2.20 per five sweeps in *Kharif*, 2014. The minimum population was recorded

at 105 DAT 1.20 and 0.80 at 30 DAT per five sweeps during *Kharif*, 2013 and 2014 respectively.

Apanteles sp

The parasitoid *Apanteles sp* was recorded maximum at 90 DAT with 3.00 and 3.00 at 105 DAT per five sweeps in both experimental years and minimum was found at 30 DAT 0.40 and 0.60 per five sweeps, respectively.

Trichogramma sp

The *Trichogramma sp* activity was recorded maximum at 90 DAT with 6.60 and 4.20 per five sweeps and minimum were recorded at 30 DAT *i.e.* 0.80 and 0.80 per five sweeps during *Kharif*, 2013 and 2014 respectively.

Shivdaspur

Spiders

The highest spider population was recorded at 75 DAT *i.e.* 19.00 and 17.20 per 5 hills in both seasons *i.e.* *Kharif*, 2013 and 2014 and minimum was recorded at 30 DAT *i.e.* 3.20 and 3.20 per 5 hills during *Kharif*, 2013 and 2014 respectively. The populations were highest at 75 DAT by net sweeping with 12.60 and 13.80 per five sweeps in both experimental years (Tables 1 and 2).

Coccinellids

Coccinellids (adults and grubs) were highest at 90 DAT with 6.60 and 7.60 per hill in irrigated eco-system, minimum population was recorded at 30 DAT *i.e.* 1.80 and 1.60 at 45 DAT per 5 hills in both the experimental years 2013 and 2014 respectively. The population 8.80 and 10.80 per five sweeps were highest at 90 DAT and lowest at 75 DAT *i.e.* 2.80 and 3.00 at 30 DAT during *Kharif*, 2013 and 2014 respectively.

Dragonflies

Dragonflies' population were recorded maximum at 60 DAT *i.e.* 11.80 and 10.80 per five sweeps, minimum at 30 DAT *i.e.* 1.20 and 0.60 at 105 DAT in both years during *Kharif*, 2013 and 2014 respectively.

Earwig

Maximum population of earwig at 90 DAT *i.e.* 2.40 and 3.80 at 90 DAT per five sweeps and lowest 0.40 at 45 DAT and 1.00 at 30 DAT were observed in both experimental years *i.e.* *Kharif*, 2013 and 2014 respectively.

Apanteles sp

Population was highest at 75 DAT with 3.20 and 2.60 at 60 DAT per five sweeps and lowest population was observed 45 DAT with 1.20 and 0.40 at 45 DAT during *Kharif*, 2013 and 2014 respectively (Tables 1 and 2).

Trichogramma sp

The maximum population of *Trichogramma sp* as 3.80 at 105 DAT and 6.20 at 90 DAT per five sweeps while minimum was recorded as 1.40 at 60 DAT and 0.60 at 30 DAT during both experimental years 2013 and 2014, respectively.

Dabhasemar

Spiders

Spider population wolf spiders, long jawed spiders, orb spiders and lynx spiders *etc.* were dominating throughout cropping season in irrigated condition. The maximum population of spiders was observed at 90 DAT with 6.00, 13.6 at 60 DAT per 5 hills and 8.00 at 90 DAT, 10.40 at 75 DAT per five sweeps in both experimental years *i.e.* *Kharif* 2013 and 2014 (Tables 1 and 2).

Table.1 Occurrence of rice leaf folder and its natural enemies under irrigated condition during *Kharif*, 2013

Location/ Village	DAT	Leaf folder		Natural Enemies												
				AV. No / 5 hill			AV. No / 5 Sweeps									
		DL %	AV. No / 5 Sweeps	Spi.	Cocc.	GB	Sp.	Cocc.	GB	Dam.	Drag.	EW	Zantho.	Itoplitic	Apen	Tricho.
Murchipur	30	0.42	11.80	4.40	2.80	1.60	2.60	2.60	4.40	3.20	5.00	1.40	0.80	0.60	0.40	0.80
	45	3.86	18.60	9.00	4.20	2.60	4.20	5.40	10.40	6.80	6.60	2.40	2.00	2.40	1.60	1.60
	60	8.88	24.40	17.40	5.80	5.80	9.60	8.40	10.00	5.60	16.20	5.00	1.80	3.20	2.40	1.40
	75	8.91	33.60	23.60	8.40	7.40	12.00	4.20	7.80	3.80	8.40	2.80	3.40	1.40	2.80	1.80
	90	10.88	28.20	10.20	7.00	6.20	6.80	9.40	12.60	6.80	4.80	2.40	4.60	3.60	3.00	6.60
	105	10.94	22.00	19.60	3.60	4.60	8.60	8.60	7.00	3.80	4.60	1.20	4.00	1.80	1.20	4.00
	-	7.32	23.10	14.03	5.30	4.70	7.30	6.43	8.70	5.00	7.60	2.53	2.77	2.17	1.90	2.70
Shivdaspur	30	0.47	8.20	3.20	1.80	1.00	1.20	4.00	8.60	2.40	1.20	1.00	0.40	0.40	0.00	0.00
	45	4.25	14.40	5.00	2.20	1.80	4.80	4.60	3.20	5.40	5.00	0.40	2.00	1.40	1.20	1.60
	60	10.21	25.20	13.80	4.60	3.60	5.40	4.80	5.40	4.00	11.80	4.40	1.20	1.60	1.60	1.40
	75	13.78	30.40	19.00	4.60	5.80	12.60	2.80	3.60	5.40	6.60	1.80	2.00	2.00	3.20	2.20
	90	15.89	28.20	7.60	6.60	4.20	4.20	8.80	5.60	5.60	5.80	2.40	1.80	3.00	2.20	3.00
	105	19.49	18.00	11.00	4.20	1.80	5.40	3.60	4.00	1.20	2.00	1.60	1.20	1.20	2.00	3.80
	-	10.68	20.73	9.93	4.00	3.03	5.60	4.77	5.07	4.00	5.40	1.93	1.43	1.60	1.70	2.00
Dabhasamer	30	1.23	7.40	2.60	1.00	0.60	0.8	0.80	2.60	1.00	2.40	0.20	0.00	0.00	0.40	0.00
	45	3.50	12.40	6.00	2.60	2.00	3.20	3.20	3.60	4.60	3.00	1.00	1.80	1.40	1.80	0.80
	60	11.42	22.00	5.40	4.40	5.40	5.20	5.20	7.40	6.40	8.00	5.00	1.80	2.60	1.40	1.60
	75	16.81	28.20	4.80	7.00	4.80	2.80	2.80	3.60	8.20	6.60	2.20	2.00	0.60	1.80	0.80
	90	18.71	27.20	6.00	5.20	6.00	8.00	8.00	8.80	5.00	2.00	1.80	1.40	1.80	3.20	4.60
	105	21.03	18.00	3.60	4.40	3.60	4.80	4.80	4.00	1.60	2.60	0.80	1.60	1.20	1.80	2.60
Mean	-	12.12	19.20	4.73	4.10	3.73	4.13	4.13	5.00	4.47	4.10	1.83	1.43	1.27	1.73	1.73

DL- Damage leaf, Spi- Spider, Cocc.- Coccinellid, GB- Ground beetle, Dam.- Damsel fly, Drag.- Dragon fly, EW- Ear wig, Zantho-*Zanthopimpla* sp, Itoplitic-*Itoplitic* sp, Apen.- *Apenilous* sp, Tricho.- *Trichomma* sp

Table.2 Occurrence of rice leaf folder and its natural enemies under irrigated condition during *Kharif*, 2014

Location/ Village	DAT	Leaf folder		Natural Enemies												
		DL %	AV No/5 sweeps	AV. No /5 hill			AV. No/ 5 Sweeps									
				Spider	Cocc.	GB	Spider	Cocc.	GB	Dam	Drag.	EW	Zantho.	Itoplitic	Apen.	Tricho.
Murchipur	30	0.75	6.60	2.60	1.90	1.20	2.00	1.60	3.20	2.00	2.80	0.80	0.20	0.00	0.60	0.00
	45	3.82	12.20	5.80	2.80	2.20	5.00	4.20	6.00	2.60	5.00	1.00	1.00	1.20	1.40	1.60
	60	8.70	20.20	12.60	4.20	5.00	6.60	5.20	6.60	3.80	10.60	1.00	1.00	2.00	1.60	0.80
	75	9.91	24.40	22.40	5.60	4.40	10.20	1.80	5.00	5.00	6.00	1.80	1.80	1.60	2.20	1.40
	90	11.28	28.20	8.20	7.60	6.80	3.20	7.60	6.60	5.60	2.40	2.20	2.20	2.00	2.40	4.20
	105	9.02	19.00	20.80	5.40	4.80	7.60	4.40	5.50	2.20	2.50	1.80	1.80	1.80	3.00	3.40
	-	7.25	18.43	12.07	4.58	4.07	5.77	4.13	5.48	3.53	4.88	1.43	1.33	1.43	1.87	1.90
Shivdaspur	30	0.65	8.20	3.20	3.60	1.20	3.20	3.00	3.80	2.40	4.40	1.00	0.20	0.80	0.40	0.60
	45	4.07	17.00	8.40	1.60	2.40	5.20	3.20	7.20	7.60	5.20	2.00	1.40	2.20	2.20	2.00
	60	11.56	22.80	16.20	8.20	5.60	10.8	5.20	10.60	5.00	10.80	3.60	2.00	1.40	2.60	1.80
	75	14.51	31.80	17.20	7.60	6.20	13.8	3.40	6.20	3.60	9.00	3.60	2.40	2.80	1.80	2.20
	90	16.00	33.40	10.40	5.00	7.60	5.40	10.8	14.40	8.40	5.60	3.80	4.40	4.20	2.20	6.20
	105	18.92	22.40	13.20	3.40	2.00	5.60	7.20	3.80	4.00	0.60	1.00	1.40	2.00	1.40	1.20
	-	10.95	22.60	11.43	4.90	4.17	7.33	4.57	7.67	5.17	5.93	2.50	1.97	2.23	1.77	2.33
Dabhasamer	30	1.28	12.20	1.60	1.4	1.40	1.40	3.20	1.80	2.20	6.80	3.60	0.20	1.00	0.40	1.80
	45	3.28	15.80	9.60	1.0	1.40	6.00	4.20	8.20	4.40	2.20	1.60	1.80	3.40	1.40	1.40
	60	12.65	27.20	13.60	4.0	5.20	4.60	11.00	9.00	4.40	13.40	6.00	2.00	3.40	2.00	1.40
	75	17.05	29.80	8.40	9.8	5.40	10.40	4.20	9.00	5.20	5.40	1.60	2.80	2.00	2.60	1.40
	90	18.50	34.00	8.40	7.2	5.80	5.80	8.40	13.40	7.40	5.40	2.60	1.80	2.40	4.60	4.80
	105	22.91	21.60	11.60	3.0	1.80	10.20	8.00	7.20	3.80	2.60	2.60	1.40	1.80	1.40	3.60
Mean	-	12.61	23.43	8.87	4.40	3.50	6.40	6.50	8.10	4.57	5.97	3.00	1.67	2.33	2.07	2.40

DL- Damage leaf, Spi- Spider, Cocc.- Coccinellid, GB- Ground beetle, Dam.- Damsel fly, Drag.- Dragon fly, EW- Ear wig, Zantho-*Zanthopimpla* sp, Itoplitic-*Itoplitic* sp, Apen.- *Apenilous* sp, Tricho.- *Trichogramma* sp

Table.3 Correlations of leaf folder and natural enemies with abiotic factors under irrigated condition during *Kharif*, 2013 and 2014

Year of Observation	Location/ Village	Variables		Leaf folder		Natural Enemies			
				DL %	AV. No / 5 Sweeps	Per 5 hill		Per 5 sweeps	
						Spider	Insect	Spider	Insect
2013	Murchipur	Temperature °C	Mini	-0.761	-0.450	-0.489	-0.335	-0.431	-0.175
			Maxi	-0.711	-0.744	-0.662	-0.676	-0.674	-0.119
		Rain fall (mm)		-0.049	0.471	0.471	0.527	0.528	-0.248
	Shivdaspur	Temperature °C	Mini	-0.904*	-0.372	-0.301	-0.433	-0.265	-0.135
			Maxi	-0.821*	-0.644	-0.616	-0.692	-0.641	-0.250
		Rain fall (mm)		-0.052	0.400	0.662	0.364	0.714	0.025
	Dabhasamer	Temperature °C	Mini	-0.892*	-0.479	0.065	-0.701	-0.519	-0.176
			Maxi	-0.867*	-0.724	0.031	-0.782	-0.341	-0.262
		Rain fall (mm)		0.040	0.365	-0.177	0.182	-0.438	0.029
2014	Murchipur	Temperature °C	Mini	-0.910*	-0.915*	-0.476	-0.959**	-0.292	-0.828*
			Maxi	-0.525	-0.526	-0.626	-0.417	-0.680	-0.406
		Rain fall (mm)		-0.017	0.062	0.294	-0.164	0.528	-0.128
	Shivdaspur	Temperatur °C	Mini	-0.874*	-0.899*	-0.519	-0.494	-0.213	-0.813*
			Maxi	-0.520	-0.643	-0.526	-0.160	-0.432	-0.415
		Rain fall (mm)		-0.130	0.223	0.249	0.137	0.543	0.102
	Dabhasamer	Temperatur °C	Mini	-0.850*	-0.840*	-0.488	-0.646	-0.615	-0.686
			Maxi	-0.489	-0.403	-0.368	-0.418	-0.875*	-0.125
		Rain fall (mm)		-0.147	0.044	-0.137	0.322	0.413	-0.275

Significant at 5% level *

Significant at 1% level **

DL- Damage leaf

Coccinellids

The highest population of coccinellids recorded at 75 DAT with 7.00 and 9.80 at 75 DAT per 5 hills and 8.0 at 90 DAT and 11.00 at 60 DAT per five sweeps in season *Kharif*, 2013 and 2014.

The minimum population was recorded at 30 DAT *i.e.* 1.0 and 1.0 at 45 DAT per five hills and 0.80 at 30 DAT and 3.20 at 30 DAT per five sweeps during *Kharif*, 2013 and 2014 respectively.

Dragonflies

Maximum population of dragonfly was recorded as 8.00 at 45 DAT and 13.40 at 60 DAT per five sweeps in both season *i.e.* *Kharif*, 2013 and 2014, minimum as 2.0 at 90 DAT and 2.20 at 45 DAT per five sweeps respectively.

Apanteles sp

The *Apanteles sp* activity was highest with 3.2 at 90 DAT and 4.60 at 90 DAT per five sweeps and lowest population was observed with 0.40 at 30 DAT and 0.40 at 30 DAT during both *Kharif* season (Tables 1 and 2).

Trichogramma sp

The maximum population of *Trichogramma sp* as 4.60 at 90 DAT, and 4.80 at 90 DAT per five sweeps while minimum was recorded as 0.80 at 30 DAT, 1.40 at 45 DAT during both experimental years, respectively. Minimum population (per 5 hills and per five sweeps) of spiders, coccinellids ground beetles damselflies, dragonflies, earwigs and the parasitoids *Apanteles sp*, *Itopectic sp*, *Xanthopimpla sp* and *Trichogramma sp* was recorded on 30 DAT of crop during both experimental years. Similar results were observed by Tiwari *et al.*, (2001).

Correlation coefficient between weather parameters and rice leaf folder and their natural enemies

Murchipur

Leaf folder

Negative correlations of leaf folder population with minimum and maximum temperature were -0.450, and -0.744 and positive correlation with rain fall 0.471 respectively, while the damage by leaf folder showed negative correlations with minimum and maximum temperature and rainfall (-0.761, -0.711 and -0.049) respectively in *Kharif*, 2013. During *Kharif*, 2014, the population of leaf folder was negative significant correlations with maximum temperature and non-significant correlation with minimum temperature (-0.915*, and -0.526) and positive correlation with rain fall (0.062) respectively, while negative correlation was found between leaf folder damage and minimum and maximum temperature and rainfall (-0.910*, -0.525 and -0.017) respectively and its damage showed significant negative correlations with maximum temperature (Table 3).

Natural enemies

The population of natural enemies was non-significantly negatively correlated with minimum and maximum temperature (-0.335 and -0.676), while non-significant positive correlations with rainfall (0.527). The population per five sweeps showed non-significant negative correlations with minimum and maximum temperature and rainfall (-0.175, -0.119 and -0.248) in *Kharif*, 2013. However during *Kharif* 2014, per 5 hill population was significantly negatively correlated with maximum temperature (-0.959**) and non-significantly negatively correlated with minimum temperature and

rainfall (-0.417 and -0.164), while it was significant negative correlation with maximum temperature (-0.828*) and non-significantly negatively correlated with minimum temperature and rainfall (-0.406 and -0.128) per five sweeps respectively. The leaf folder population showed non-significantly negatively correlation with minimum and maximum temperature and non-significant positive correlation with rainfall during *Kharif*, 2013 and 2014 and damage per cent was significantly negatively correlated with minimum and maximum temperature was observed in villages Murchipur, Shivdaspur and Dabhasemar during *Kharif*, 2013. The present findings are comparable with the finding obtained by Bhaskar (1994); Ram *et al.*, (2014), Nigam *et al.*, (2009) and Netam and Gupta (2015).

Shivdaspur

Leaf folder

It was evident from the data that the damage by leaf folder showed significant negatively correlations with minimum and maximum temperature (-0.904* and -0.821*), and non-significant negatively correlations with rainfall (-0.052). The population per five sweeps had non-significant negative correlation with minimum and maximum temperature (-0.372 and -0.644), while non-significant positive correlation with rain fall (0.400) during *Kharif*, 2013. However, during *Kharif* 2014, the leaf folder damage was significantly negatively correlated with maximum temperature (-0.874*) and non-significantly negative correlation with minimum temperature and rainfall (-0.520 and -0.130) while significantly negatively correlated with maximum temperature (-0.899*) and non-significantly negatively correlation with minimum temperature (-0.643) and rainfall showed positive correlation (0.233) (Table 3).

Natural enemies

The population of natural enemies showed non-significant negative correlations were with minimum and maximum temperature (-0.433 and -0.692) whereas non-significant positive correlation with and rainfall (0.364) during *Kharif*, 2013. The population per five sweeps with minimum and maximum temperature (-0.135 and -0.250) was non-significantly negatively correlations and non-significant positive correlations with rainfall (0.025) in the same year.

However, during *Kharif*, 2014 the natural enemies population per 5 hill was showed non-significant negative correlations were with minimum and maximum temperature (-0.494 and -0.160), whereas non-significant positive correlation with and rainfall (0.137), the population per five sweeps with maximum temperature significant negative correlations was (-0.813*) and non-significantly negatively correlations with minimum temperature (-0.415) and non-significant positive correlations with rainfall (0.102) (Table 3).

Dabhasemar

Leaf folder

The results of correlation studies found on leaf folder damage were negative significant correlation with minimum and maximum temperature (-0.892* and -0.821*) while positive non-significant correlation was found with rainfall (0.040), whereas its population showed non-significant negative correlation with minimum and maximum temperature (-0.479 and -0.724) while positive non-significant correlation with rainfall during *Kharif* 2013. However, during *Kharif* 2014, its population was significant negative correlation with maximum temperature (-0.899*) and non-significant negative

correlation with minimum temperature (-0.403) while significantly positively correlated with rainfall (0.0044) and its damage was negatively significantly correlated with maximum temperature (-0.850*) and non-significant negative correlation with minimum temperature and rainfall (-0.489 and -0.147) respectively.

Natural enemies

The results of correlation studies showed that per five hill population of natural enemies was non-significantly negatively correlated with minimum and maximum temperature (-0.701 and -0.782) and non-significantly positively correlated with rainfall (0.182).

The population per five sweeps showed non-significant negative correlations with minimum and maximum temperature (-0.176 and -0.262) and non-significantly positively correlated with rainfall (0.029) in *Kharif*, 2013. However, during *Kharif* 2014 per 5 hill population was non-significantly negatively correlated with minimum and maximum temperature (-0.646 and -0.418), while it was non-significant positive correlation with rainfall (0.322) whereas non-significantly negatively correlated with minimum and maximum temperature and rainfall (-0.686, -0.125 and -0.275) per five sweeps, respectively (Table 3). The present findings are comparable with the finding obtained by Bhaskar (1994), Ram *et al.*, (2014), Nigam *et al.*, (2009) and Netam and Gupta (2015).

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