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Effect of Meteorological Factors on Population Dynamics of Rice Leaf Folder and Natural Enemy in Rice Ecosystem of Balaghat District, Madhya Pradesh

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Abstract

Leaf folder is the most destructive pest of rice crop and it is regularly noticed in the rice ecosystem of Balaghat district. Effect of abiotic factors on rice leaf folder infestation along with population dynamics and natural enemies in rice ecosystem of Balaghat district was studied at Research Farm of College of Agriculture, Waraseoni as well as farmer's field of Balaghat, Madhya Pradesh during the period of two years *i.e. Kharif*, 2019 and *Kharif*, 2020. The results revealed that seasonal activity of leaf folder (3.03 adult trapped/day, seasonal mean) was recorded throughout the cropping season with the highest adult catches of 7.33/day during the third week of September. During this time, maximum (2.58%) percent leaf damage by leaf folder was observed. the maximum activities of natural enemies were recorded and vegetative and panicle stage of rice crop. Percent leaf damage and population activity had a significant positive correlation with relative humidity at 7.00 hrs (r=0.698), at 14.00 hrs (r=0.576) and rainfall (r=0.524). The correlation coefficient between leaf folder and bioagent concluded that a significant positive relationship existed between percent leaf infestation by leaf folder and dragon/damselfly, meadow grasshopper and bugs with the correlation coefficient value of r=0.865, 0.612 and 0.766, respectively.

***Key words** : Rice leaf folder, natural enemy, population dynamics, abiotic factors, correlation.*

Introduction

Rice (*Oryza sativa* L.) is an important food grain crop in India, which provides high calories food for every Indian. Balaghat district is very popular in rice production known as the "rice bowl" of Madhya Pradesh. Rice can be grown throughout the year in this area due to favorable agro-climatic conditions. The total cultivated area of Balaghat district 2.66 lakh ha comes under rice cultivation, comprises nearly 90% of Kharif and 10% of summer season rice with a total production of 6.88 lakh tonnes and the productivity of 2512 kg/ ha. Rice crops are more prone to the attack of insect pests due to three different growth stages during the cropping season of rice crop i.e. terrestrial, semi-aquatic, and aquatic habitat (1). Leaf folder is the most destructive pest of rice crop and it is regularly noticed in the rice ecosystem of Balaghat district. Rice leaves are folded by the larva of the leaf folder, after that the larva hides in this folder leaves and scrapes the chlorophyll content, which leads to the formation of white parallel streaks on the leaves. This type of damage is caused by leaf folder larva at vegetative as well as in the panicle stage of rice crop. The damage in the vegetative stage does not directly affect the yield of paddy but affects the growth and development of plants. During the panicle stage, the attack of the leaf folder directly affects the yield of paddy and it is reduced yield up to 60% in severe damage conditions (2). The populations of rice leaf folders fluctuate during cropping seasons with the weather parameters of this region. The highest number of larvae was observed during the fourth week of August and the first week of September (3). (4) reported that leaf folder infestation was started at about 33rd standard meteorological weeks gaining the highest peak of abundance at about 39th standard meteorological weeks. Hence, study on population dynamics of leaf folder is essential as these provide information on the damaged status of leaf folder and their predator fauna and also help in identifying the vulnerable stage of the crop. This information is very useful in very effective management strategies for the leaf folder at the various growth stages of the crop.

Materials and Methods

The present studies on rice leaf folder infestation and its population dynamics with their natural enemy in rice ecosystem of Balaghat district were conducted at two locations i.e. farmers field and Research farm, College of Agriculture Balaghat. The leaf folder infestation and seasonal activity of natural enemy were recorded by the survey worked at farmers filed from 10 villages of two blocks at fortnightly intervals during *Kharif* 2019 and *Kharif* 2020. Fortnightly observations on percent leaf damage by leaf folder in rice crop and their natural enemies were taken from five randomly selected hills in five spots of each field. A total of five fields were selected from each

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Table-1 : Population dynamics of rice leaf folder and natural enemies on rice at Balaghat, Madhya Pradesh during *Kharif*, 2019 and 2020.

SMW	Crop age (in days)	Crop stages	Rice leaf folder		Population of natural enemies				
			Mean adult catch/light trap	% leaf damage	Spider /hill	Odonata /sweep	Grasshopper /hill	Wasp /sweep	Bugs /hill
26	15	Seedling	0.05	0.0	0.00	0.0	0.00	0.0	0.0
27	22	Seedling	0.35	0.0	0.0	0.0	0.0	0.0	0.0
28	29	Vegetative	0.77	0.06	0.0	0.74	0.0	0.0	0.0
29	36	Vegetative	1.52	0.20	0.0	0.56	0.0	0.15	0.0
30	43	Vegetative	2.68	0.11	0.0	0.33	0.0	0.57	0.0
31	50	Tillering	2.06	0.49	0.05	0.51	0.00	1.23	0.0
32	57	Tillering	3.17	0.69	0.15	0.43	0.00	1.54	0.62
33	64	Tillering	4.53	1.58	0.19	1.10	0.40	1.11	0.23
34	71	Flowering	3.38	1.99	0.21	3.36	0.12	0.98	1.12
35	78	Panicle	7.32	2.58	0.19	4.26	0.10	0.45	1.54
36	85	Panicle	7.33	2.01	0.94	1.29	0.78	1.95	2.54
37	92	Earhead	5.38	1.36	1.25	0.94	0.54	2.23	1.99
38	99	Earhead	4.26	0.51	1.69	0.58	0.24	3.45	1.03
39	106	Maturity	2.00	0.11	1.05	0.11	0.03	1.45	0.52
40	113	Maturity	0.65	0.07	0.52	0.0	0.01	0.55	0.10

Table-2 : Correlation coefficient between rice leaf folder with different weather parameters during *Kharif*, 2019 and 2020.

Meteorological parameters	Rice leaf folder		Natural enemies				
	Mean adult catch/light trap	% leaf damage	Spider /hill	Odonata /sweep	Grass-hopper /hill	Wasp/ sweep	Bugs/ hill
Maximum temperature (°C)	-0.532*	-0.562*	-0.167	-0.437	-0.333	-0.306	-0.382
Minimum temperature (°C)	-0.255	-0.307	-0.215	-0.262	-0.157	-0.216	-0.205
Relative humidity (%) 7 hr	0.698*	0.696*	0.493	0.568*	0.616*	0.592*	0.654*
Relative humidity (%) 14 hr	0.576*	0.578*	0.054	0.480	0.427	0.313	0.471
Rainfall (mm)	0.524*	0.538*	0.026	0.496	0.336	0.270	0.470
Evaporation (mm)	0.145	-0.634*	-0.337	-0.508*	-0.528*	-0.495	-0.539*
Sunshine (hr.)	-0.265	-0.398	0.353	-0.415	-0.104	0.107	-0.168

*Correlation is significant at 0.05 level (2-tailed)

Table-3 : Correlation (r) between rice leaf folder and natural enemies on rice.

Population of natural enemies	Mean adult catch/light trap	% leaf damage
Spider	0.436	0.155
Odonata	0.646*	0.865*
Grasshopper	0.747*	0.612*
Wasp	0.547*	0.271
Bugs	0.864*	0.766*

*Correlation is significant at 0.05 level (2-tailed)

village of two blocks. Leaf folder damage was worked out by using the following formula :

$$\text{Percent incidence } \frac{\text{Number of damaged leaves}}{\text{Total number of leaves}} \times 100$$

The population dynamics study was carried out at Research farm, College of Agriculture Balaghat. The light trap was installed for recording the seasonal activity of the rice folder during *Kharif* 2019 and *Kharif* 2020. The adult trapped in the light trap was observed on daily basis and finally converted into a weekly total and calculated mean per day per week (weekly mean/day).

Populations of leaf folder and the natural enemy were subjected to correlation and regression studies, where, the population of leaf folder natural enemy and rice leaf folder infestation were an as dependent factor and meteorological parameters such as temperature, relative humidity, rainfall, evaporation and sunshine as independent factors. If the correlation was found to be significant then linear regression equation $y = a + bx$ was worked out. Here y is the dependant parameter; a is constant; b is the regression coefficient and x is the independent parameter.

Results and Discussion

The data on leaf folder adult catches in a light trap, infestation percent of leaf folder and whether parameters

Correlation matrix

	Adult trapped/ day	% LD	Spider	Odonata	Grasshopper	Wasp	Bugs	Max. T	Min. T	RH@ 7.00 hrs	RH@ 14.00hrs	Rainfall	Evaporation	Sun-shine
Adult trapped/day	1.000													
% LD	0.879	1.000												
Spider	0.436	0.155	1.000											
Odonata	0.646	0.865	-0.064	1.000										
Grasshopper	0.747	0.612	0.565	0.197	1.000									
Wasp	0.547	0.271	0.871	-0.004	0.573	1.000								
Bugs	0.864	0.766	0.606	0.521	0.812	0.587	1.000							
Max. T	-0.532	-0.565	-0.050	-0.377	-0.279	-0.273	-0.305	1.000						
Min. T	-0.255	-0.275	-0.207	-0.254	-0.042	-0.157	-0.180	0.768	1.000					
RH@7.00 hrs	0.698	0.673	0.380	0.441	0.517	0.463	0.620	-0.893	-0.789	1.000				
RH@14.00hrs	0.576	0.590	-0.087	0.335	0.436	0.247	0.386	-0.835	-0.365	0.702	1.000			
Rainfall	0.524	0.495	-0.065	0.371	0.210	0.041	0.423	-0.619	-0.409	0.584	0.649	1.000		
Evaporation	-0.645	-0.621	-0.243	-0.371	-0.487	-0.385	-0.457	0.895	0.688	-0.900	-0.757	-0.480	1.000	
Sunshine	-0.265	-0.430	0.490	-0.382	-0.052	0.180	-0.060	0.647	0.257	-0.364	-0.816	-0.595	0.480	1.000

are presented in Table-1. The observed adult population and percent leaf infestation of leaf folder during *Kharif* 2019 and *Kharif* 2020 is graphically depicted in fig.-1. On the basis of the pooled mean of *Kharif*, 2019 and *Kharif*, 2020, the mean adult catches in the light trap appeared from the first week of July and after that, the population was gradually increased. Two peaks were recorded during the 36th standard meteorological week i.e. 3rd week of September and the 35th standard meteorological week *i.e.* 2nd week of September, where adult catches in the light trap per day reached the highest with 7.33 and 7.32, respectively. Thereafter, the seasonal activity of the leaf folder decreased gradually up to the fourth week of October. The seasonal mean of 3.03 adults trapped/day was recorded during the *Kharif* season of 2019 and 2020. Leaf folder was regarded as a most serious damaging pest, which was active throughout the crop duration specially it vegetative and reproductive stage of the crop.

During the study period, weekly fluctuation of maximum and minimum temperature ranged 29.60 to 35.35°C and 24.65 to 26.75°C. Relative humidity at 7.00 hrs and 14.00 hrs ranged from 81.5 to 92.50 % and 63.0 to 80.0 %, respectively. Similarly, rainfall varied from 7.3 mm to 144.80 mm during *Kharif* season of 2019 and 2020.

The correlation coefficient (r) calculated between rice leaf folder adult catches in light trap and weather parameters, percent leaf damage and weather parameters are given in Table-2. There was a significant negative correlation between the adult population taped in the light trap and maximum and minimum temperature with correlation coefficient values of r= -0.532 and r= -0.516, respectively. While the significant positive correlation was observed between relative humidity at 7.00 hrs (r=0.698) and 14.00 hrs (r=0.576) and adults trapped per day in a light trap. Rainfall is also significantly positively correlated with the population activity of the leaf folder. With the correlation coefficient value of r=0.524.

The regression equation for relative humidity at 7.00 hrs and 14.00 hrs were :

$$y = a+bx \text{ and } y = a+bx1+bx2$$

Here y = regression equation; a= constant; b= regression coefficient; x= independent parameters/relative humidity at 7.00 hrs and 14.00 hrs

The rice leaf folder infestation in terms of percent leaf damage was studied from the 28th standard metrological week *i.e.* 3rd week of July at the early vegetative stage of the crop. After the third week of July, the percent leaf damage by leaf folder was gradually increased and gained peak at 35th standard metrological week *i.e.* 2nd week of September at panicle initiation stage

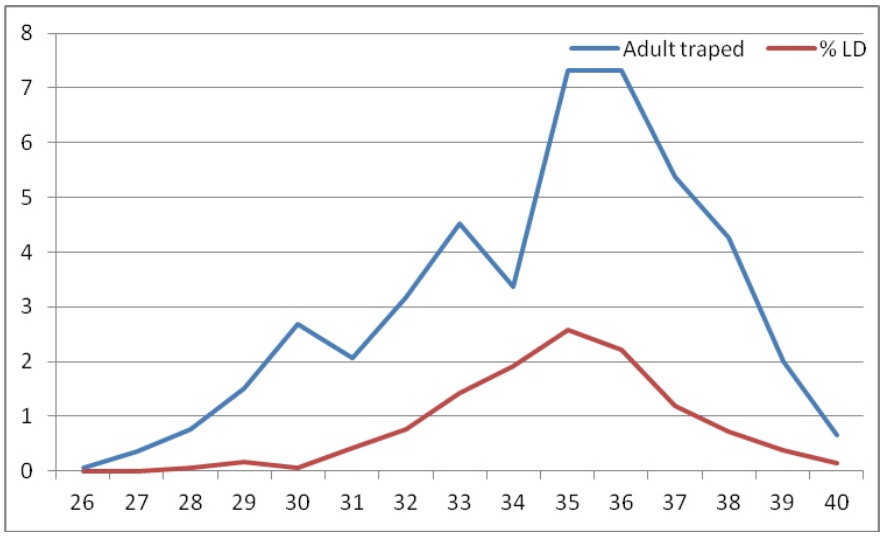

Fig.-1 : Percent infestation and population dynamics of leaf folder during *kharif* 2019 and 2020.

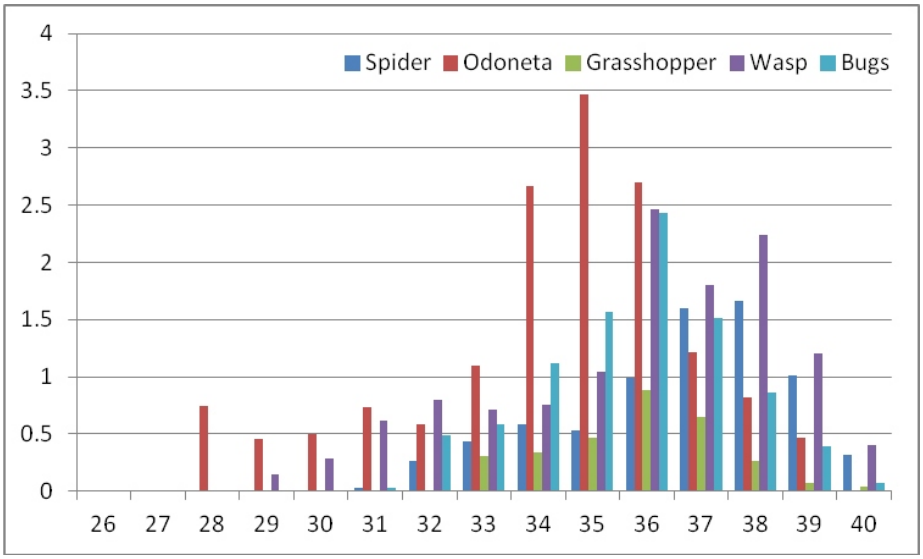

Fig.-2 : Population dynamics of natural enemies during *kharif* 2019 and 2020.

with 2.57 percent leaf damage. After that, the leaf folder infestation was declined up to the maturity stage of the crop. The correlation studies were worked out between percent leaf damage and the weekly mean of meteorological parameters. The percent leaf damage showed a significant negative correlation (r= -0.562) with the maximum temperature, whereas a significant positive correlation was recorded between percent leaf damage and relative humidity at 7.00 hrs, relative humidity at 14.00 hrs and rainfall with the correlation coefficient value of r=0.696, r=0.578 and r=0.538, respectively.

(5) also observed the peak infestation of leaf folder occurred in the month of September and October in Kendujhar, Orissa which is in conformity with the present finding. The present finding was also in accordance with the results of (6) who reported significantly maximum leaf folder incidence during the month of September in Tamilnadu. (7) indicated that the peak seasonal activity of the leaf folder occurred in the first fortnight of October while, in the present investigation, the second peak activity was noticed during the first fortnight of September. (8) revealed that the minimum level of infestation was recorded during the month of July and reached a maximum during the month of September with 33.2 percent leaf infestation. The present investigation also revealed maximum leaf infestation during September with 2.57 % infestation. (9) reported that leaf folder infestation initiated from 36th SMW during Kharif season and reached its peak level during 43rd SMW while, in present findings, infestation started from 28th SMW and reached its peak infestation during 36th SMW followed by 35th SMW. Present findings were contradictory with those of (4) who reported that leaf folder infestation was initiated during 33 SMW and peak abundance during 39 SMW in Navsari, Gujarat.

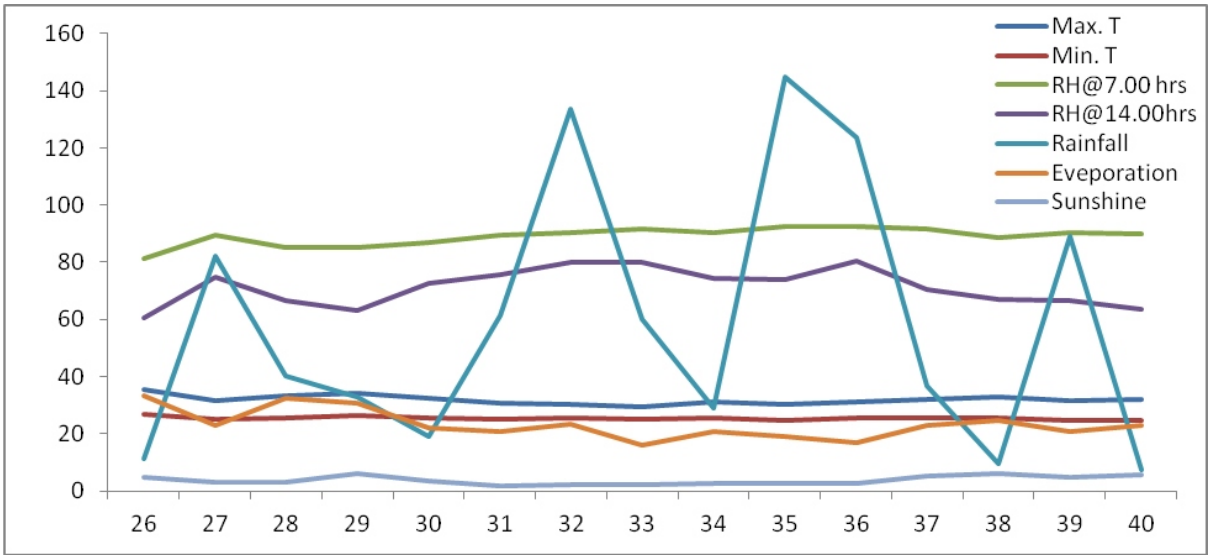

Fig.-3 : Fluctuation of abiotic factors during cropping season of *Kharif* -2019 and 2020.

The data on population dynamics of the natural enemies are given in Table-3 and graphically presented in fig.-2, which revealed that the maximum activities of natural enemies were recorded and vegetative and panicle stage of rice crop. The Odonata (dragon and damselfly) was observed as a major natural enemy and they noticed first on the crop in 28th standard meteorological week *i.e.* 3rd week of July with 0.74 fly/sweep net. They were recorded as very active at the flowering and panicle initiation stage of rice with the maximum peak (3.47 fly/sweep net) in the 35th standard meteorological week *i.e.* 2nd week of September. The next active natural enemy was recorded as a meadow grasshopper from the 3rd week of August with the very low number of 0.01 grasshopper/hill. The maximum population of grasshoppers was recorded at the panicle stage of rice in the 36th standard meteorological week. Species of spider (*Lynx* sp.) were also recorded as major bio-agent in the rice ecosystem in the Balaghat district. The population of spiders was first noticed in the 31st standard meteorological week with 0.03 spider/hill. Their activity continued till the 40th standard meteorological week *i.e.* third week of October. The highest peak of 1.66 spider/ hill was observed during the 38th standard meteorological week at the ear head stage of the crop.

Besides the above natural enemies, mirid bug (*Cyrtorhinus lividipennis*) and hymenopteran wasps were active from the last week of July to the third week of October. Peak activity of mirid bug and wasps were noticed during 36th standard meteorological week *i.e.* 3rd week of September with 2.43/bug/hill and 2.46 wasp/sweep net, respectively. The maximum population dynamics of natural enemies were observed at that time when rice leaf folder infestation was high. (10) reported that the spider, dragonfly mirid bug was the most active natural enemy during the *Kharif* season of rice crop with the peak in the 41st standard meteorological week. (3) reported *Cotesia* sp. as dominating larval parasitoid. A spider (*Lycosa* sp.) is also predated upon larvae of pest, whereas, in the present studies spider (*Lynx* sp.) was recorded as a major bio-agent against the pest.

To observe any relationship exists between natural enemies and rice leaf folder infestation, the leaf damage percent was correlated with the population of natural enemies. It revealed that the rice leaf folder infestation was significantly positively correlated with the population of dragon/damselfly, meadow grasshopper and mirid bug with correlation coefficients (r) of 0.865, 0.612 and 0.8766, respectively. On the basis of the correlation coefficient study, it is clear that as the infestation of rice leaf folder increases population of Odonata fly, meadow grasshopper and mired bug are also increases. However, non-significant positive correlation was found between percent leaf damage and population of spider and hymenopteran wasp. The correlation between the population of natural enemies and weather parameters was worked out. A significant positive correlation was recorded between relative humidity at 7.00 hrs and population of Odonata (r=0.568), meadow grasshopper (r=0.616), hymenopteran wasp (r=0.692) and mirid bug (r=0.654).

Conclusions

Based on the present investigations of both years, it is concluded that the peak activity of the rice leaf folder was noticed at the panicle stage of the rice crop in mid of September. The highest population activity at the panicle stage was direct associated with the reduction of rice

yield. Percent leaf damage and population activity had a significant positive correlation with relative humidity and rainfall. The correlation coefficient between leaf folder and bio-agent concluded that a significantly positive relation existed between percent leaf infestation by leaf folder and dragon/damselfly, meadow grasshopper and bugs.

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