



# Bio-Ecology of Lepidopteran Pests and Natural Enemies in Rice Ecosystem of Balaghat District

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**Abstract:** In India, tentatively 100 insects have been reported as pests of rice and 20 of these are accepted to be key pests causing more than 30% yield loss from germination to harvest of the crop. The stem borers and leaf folders both are of economic importance and they damage the rice plants at all the stages of crop growth and are the key factors responsible for poor rice yield. In view of the above background the present experiments were conducted to study on "Bio-ecology of stem borer and leaf folder in rice ecosystem of Balaghat district" to find out the seasonal incidence and species diversity of stem borer and leaf folder with natural enemies in rice ecosystem. The highest mean percent dead heart and white ear head caused by stem borer were recorded in Mehandiwada village of Waraseoni and lowest percent were recorded in Belgoan village of Lalburra. Whereas, the maximum percent damaged leaves caused by leaf folder was recorded in Bakoda village followed by Mohgaon village (5.17% DL) of Lalburra block and minimum percent damaged leaves (4.39%) was recorded in Savngi village of Waraseoni block followed by Sihora (4.50% DL) village of Lalburra block and Kope (4.55% DL) village of Waraseoni block. The total numbers of five natural enemies *i.e.* hymenoptera wasp, orthoptera grasshoppers (meadow grasshopper), odonata fly (dragonfly and damselfly), hemipteran bugs and spider were observed at different stages of crop growth. Among natural enemies, the abundance was in the order of meadow grasshopper > Odonata fly > hymenoptera wasp > spider > hemipteran bugs. The three species of stem borer *i.e.* *Scirpophaga insertulas*, *Sesamia inferens* and *Scirpophaga innotata* were observed in Balaghat district. Among all three species of stem borer, the highest population was recorded with *Scirpophaga insertulas* (71.24%) and followed by *Sesamia inferens* (20.61%) and *Scirpophaga innotata* (8.16%). The three species of rice leaf folder *i.e.* *Cnaphalocrosis medinalis*, *Marasmia patnalis* and *Marasmia ruralis* were observed in Balaghat district. Among all three species of leaf folder, the highest population (85.16%) was observed with *C. medinalis* followed by *M. patnalis* 12.38% and *M. ruralis* 2.46%.

**Keywords:** Species diversity, Seasonal activity, Stem borer, Leaf folder, Bioecology

Rice is one of the most important cereal crops which providing food for nearly half the population at the global level (Fukagawa and Ziska 2019). More than 2000 million people in Asia and 100 million in Africa and Latin America depend on rice as a major food. In India, rice grows up in about 43.86 million hectares with a production of 112.91 million tonnes that shares 19.51 percent of world rice production with average productivity of 2578 kg/ha (Anonymous, 2020). In India, insect pests are the most important biological constraints limiting rice yield potential and reflect large scale reduction both in quality and quantity throughout the world (Arora *et al.*, 2019). More than 10 species of insect pests have been reported to severe damage on rice crop in Madhya Pradesh, of which stem borers (*Scirpophaga* sp., *Chilo* sp. and *Sesamia inferens* Walk.) and leaf folders (*Cnaphalocrosis medinalis*, Guen. and *Marasmia patnalis*, Bradley) are key factors responsible for poor rice yield. The stem borer feeds on the inner part of the stem without cutting it, which shows the dead heart during their growth stage, which results in a reduction in the spikelets per panicle, hindering the ripening of panicles, which eventually leads to grain weight loss (January *et al* 2020). The rice leaf folder affects the plant by causing transparent patches on the leaf as it feeds on the foliage and scraps the green mesophyll tissue of the plant (Chintalapati *et al* 2017).

## MATERIAL AND METHODS

The experiments were conducted at Research Farm of JNKVV-

College of Agriculture, Balaghat, Murjhad Farm, Waraseoni and farmer's field of Balaghat district, Madhya Pradesh during two consecutive *Kharif* seasons of 2019 and 2020. Two blocks from the Balaghat district *i.e.* Lalburra and Waraseoni were selected for the survey works of the study. The 1250 samples were observed from these two blocks in 5x5x5x5 manner (*i.e.* five villages from each block, five fields from each village and five spots from each field and five hills from each spot). Observations were recorded at fifteen days interval from nursery to harvest during *kharif* 2019 and 2020. Standard procedure was followed to record the observations on incidence of stem borers and leaf folders of paddy (Bentur *et al* 2012). **Stem borer:** Counts were taken on a number of dead hearts/white ears and a total number of tillers/panicles from five randomly selected hills. The percent incidence (dead heart/ white ears) was calculated.

**Leaf folder:** The damaged leaves and a total number of leaves from 10 randomly selected hills were observed in each plot. The percentage of leaf damage was calculated.

**Species diversity:** The total 50 adults of the stem borers and 50 adults of the leaf folders were collected from different locations of two blocks in the Balaghat district. Stem borer and leaf folder moth's abundance was determined by collection from sweep net and light traps sampling from different locations. The observation on adults of stem borer and leaf folder was done by collection from insect net and light traps from selected places. The percentage of occurrence of

stem borer and leaf folder in the collected population from different regions was also worked out.

**Natural enemies:** The population counts of the natural enemies were made simultaneously in all the same locations and on the same spot-on which insect pest population was recorded. Total 20 sweeps of collection net were made on five spots from each field. The observations were recorded at 30, 45, 60, 75 and 90 days after transplanting. The common predators such as wasps, spiders, mirids, dragon flies and grasshoppers were counted on each spot and averaged to express per 20 sweep basis.

## RESULTS AND DISCUSSION

### Seasonal Incidence

**Stem borer:** The average egg mass of 0.055 per hill was recorded in 10 villages of two blocks during *kharif*, 2019 and 2020. Among the villages, the maximum number of egg mass *i.e.* 0.101 per hill in Ganeshpur and minimum egg mass (0.022/hill) in Savngi. Highest mean (5.96%) dead heart was in the Mehndiwada and the lowest (3.52%) in Belgaon village. The maximum percent dead heart was recorded 45 days after transplanting with 7.78 % during the survey period at the farmer field. The highest percent (6.48%) of ear head was in Mehndiwada whereas, the lowest (2.38%) in Belgaon followed by Savngi (2.86%). The highest white ear head was at 90 days after transplanting (10.04%). Das (2020) reported seven insect species *viz.*, *C. medinalis* (Guenee), *S. incertulas* (Walker), *M. separate* (walker), *Leptocorisa* spp, *Nilaparvata lugens* (Stal), *Nephotettix nigropictus* (Stal) and *N. virescence* (Distant) were recorded as major pests in paddy field. Among them, YSB (*S. incertulas*) were dominant pest species of rice cultivated in the study area. Bisen et al (2019) YSB were more in the mid to last of September, leaf folder increases at the time of reproductive phase in mid of September. Ghosh et al (2016) reported that the YSB (*S. incertulas*) were the major and serious pests of rice plant in Burdwan district, West Bengal. Justin and Preetha (2014) reported the

maximum incidence of stem borer in Agasteeswaram, Thovalai and Thuckalay blocks in Kanyakumari District. Adhikari et al (2018) reported that the *S. incertulas* was observed throughout the crop season, while its highest abundance were at the tillering stage in Chitwan and the milking stage in Lamjung. Saini (2017) reported the highest population of *S. incertulas* was recorded in Thirur (76.79%), *S. fusciflua* recorded highest from Killikulam (5.88%) and *S. virginia* was recorded in Thirupathisaram (1.90%) and reported first time from Tamil Nadu in India.

**Leaf folder:** The maximum (5.46%) damaged leaves was recorded in Bakoda followed by Mohgaon and Newargaon village and minimum was in Savngi village (4.39%) followed by Sihora and Kope. The highest percent of damaged leaves was recorded 60 days after transplanting (9.06%), whereas, the lowest was at 90 days (2.02%) followed by 30 days after transplanting. Das (2020) observed that leaf folder (*C. medinalis*) was highly abundant and dominant pest species of rice cultivated in the study area. The present findings were supported by the findings of Ghosh et al (2016) in Burdwan district, West Bengal and they reported that leaf folder (*C. medinalis*) was the major and serious pests of rice plant.

**Natural enemies:** The five natural enemies *i.e.* hymenoptera wasp, meadow grasshopper, odonata fly (dragonfly and damselfly), hemipteran bugs and spider were observed at different stages of crop. The highest relative abundance of meadow grasshopper (29%) was recorded and lowest (15%) was in spider and hemipteran bugs. Among natural enemies, the abundance was in the order of meadow grasshopper > odonata fly >hymenoptera wasp > spider > hemipteran bugs. On the basis of the mean of all natural enemies, the highest activity was recorded at the late tillering stage *i.e.* 60 days after transplanting followed by the panicle initiation stage *i.e.* 75 days after transplanting. Kumar et al. (2013) and Rautaray (2019) reported that the common natural enemy fauna of rice leaf folder *C. medinalis* comprised of 10 species predatory arthropods. Rahaman et al (2014) reported nine different natural enemies were collected

**Table 1.** Seasonal incidence of stem borer and leaf folder (Pooled mean of *Kharif*, 2019 and 2020)

Block	Village	Egg mass/hill*	DH per cent (%)				WEH per cent (%)			Damaged leaves percent (%)			
			30 DAT	45 DAT	60 DAT	Mean	75 DAT	90 DAT	Mean	30 DAT	60 DAT	90 DAT	Mean
Lalburra	Ganeshpur	0.101	5.37	7.00	4.31	5.56	2.08	9.04	5.56	3.00	8.76	1.55	4.89
	Bakoda	0.062	4.25	6.59	4.67	5.17	2.37	7.56	4.97	2.42	10.08	1.49	5.46
	Belgaon	0.034	3.13	4.96	2.49	3.52	1.05	3.70	2.38	2.23	9.04	2.76	4.82
	Sihora	0.038	3.94	5.14	4.66	4.58	1.28	6.09	3.69	1.97	8.11	2.12	4.50
	Mohgaon	0.060	4.02	5.22	3.67	4.30	2.11	6.43	4.27	2.82	9.17	2.43	5.17
	Mean	0.059	4.14	5.78	3.96	4.63	1.78	6.56	4.17	2.49	9.03	2.07	4.97
Waraseoni	Kope	0.035	4.40	6.40	3.86	4.88	2.02	7.25	4.64	2.92	8.53	2.82	4.55
	Kayadi	0.037	4.12	5.74	3.43	4.43	2.23	5.90	4.07	2.09	10.36	1.34	4.82
	Mehndiwada	0.086	5.27	7.78	4.85	5.96	2.90	10.04	6.48	3.62	7.69	1.85	4.77
	Savngi	0.022	3.37	5.16	1.97	3.50	1.12	4.61	2.86	2.03	9.03	2.13	4.39
	Newargaon	0.078	4.56	7.03	4.66	5.42	2.44	9.02	5.73	2.32	9.78	1.69	5.15
Mean	0.052	4.34	6.42	3.75	4.84	2.14	7.36	4.76	2.59	9.08	1.98	4.76	
Overall mean		0.055	4.24	6.10	3.86	4.73	1.96	6.96	4.47	2.54	9.06	2.02	4.85

\*Average of three observations (15 days after sowing, 50 & 70 days after transplanting (DAT); DH= dead heart, WEH= white ear head

from the rice fields and recorded. The population of natural enemies was highest in tillering stage and lowest in seedling stage. The relative abundance of natural enemies as ladybird beetle > long jawed spider > wolf spider > damselfly > carabid beetle > green mirid bug > lynx spider > dragon fly > ear wig.

#### Species Diversity

**Stem borer:** The three species of stem borer *i.e.* *S. insertulas* (YSB), *S. inferens* (PSB) and *S. innotata* (WSB) were observed during *Kharif*, 2019 and 2020. Among all three species, the highest population was of YSB (71.24%) in all three species followed by PSB (20.61%) and WSB (8.16%). Baskaran et al (2017) reported that three species of stem borer including *S. insertulas*, *C. suppressalis* and *S. innotata* but *S. insertulas* dominated. Rahaman et al (2014) reported five stem borer species viz; YSB, PSB, DSB, SSB (*Chilo suppressalis*), WSB (*Scirpophaga innotata*) from the rice fields. The population of stem borers highest in tillering stage and lowest in seedling stage. The relative abundance of stem borer species under investigation showed ranking order; yellow stem borer > dark headed stem borer > pink borer > white borer > stripped stem borer. Kumar (2012) reported the four species of stem borer of rice viz. YSB, PSB,

WSB, and DSB were prevalent during the crop season. However, YSB was dominant over other species of stem borer. Kanagaraj et al. (2019) reported three species of rice stem borers viz., *S. insertulas*, *S. inferens*, *C. polychrysus* occurred among which the first was dominant. Sampathkumar and Ravi (2013) reported that three stem borers species viz., YSB, PSB and dark headed borer were found in all the regions except in the hilly Zone where YSB was the only species present.

**Leaf folder:** The three species of rice leaf folder *i.e.* *C. medinalis*, *M. patnalis* and *M. ruralis* were observed in Balaghat district. Among all three, the highest population was observed with *C. medinalis* (85.16%) followed by *M. patnalis* and *M. ruralis*. Among different villages, *C. medinalis* numbers ranged from 80.30 to 89.37% with an average percent of 85.16% at different growth stages of rice crop in two blocks of Balaghat district. Kanagaraj et al (2019) reported three species of rice leaf folders viz., *C. medinalis*, *M. patnalis* and *M. ruralis* occurred among which the first was dominant. Rautaray (2019) revealed that three rice leaf folder species were noticed *i.e.* *C. medinalis* (Guenée), *M. exigua* (Bradley) and *Brachimea arotraea* (Meyrick) with the predominance of *C. medinalis*.

**Table 2.** Species diversity ratio of stem borer and leaf folder (Pooled mean of *Kharif*, 2019 and 2020)

Block	Village	Stem borer			Leaf folder		
		<i>Scirpophaga insertulas</i> (YSB %)	<i>Sesamia inferens</i> (PSB %)	<i>Scirpophaga innotata</i> (WSB %)	<i>Cnaphalocrosi medinalis</i>	<i>Marasmia patnalis</i>	<i>Marasmia ruralis</i>
Lalburra	Ganeshpur	70.66	21.56	7.78	86.44	10.64	2.93
	Bakoda	70.96	19.91	9.13	83.88	14.04	2.09
	Belgaon	69.89	21.36	8.76	89.37	9.15	1.49
	Sihora	72.92	19.27	7.82	80.30	15.27	4.43
	Mohgaon	74.32	21.46	4.22	86.56	12.72	0.73
	Mean	71.75	20.71	7.54	85.31	12.36	2.33
Waraseoni	Kope	69.01	20.17	10.82	85.18	11.58	3.25
	Kayadi	70.98	19.93	9.09	85.37	11.41	3.23
	Mehndiwada	69.88	19.05	11.08	86.66	12.00	1.35
	Savngi	72.86	21.67	5.47	81.70	14.20	4.11
	Newargaon	70.86	21.75	7.39	86.18	12.84	0.99
	Mean	70.72	20.51	8.77	85.02	12.40	2.58
Overall mean		71.24	20.61	8.16	85.16	12.38	2.46

YSB= yellow stem borer, PSB= pink stem borer, WSB= white stem borer

**Table 3.** Abundance of natural enemies in rice ecosystem of Balaghat district (Pooled mean of *Kharif*, 2019 and 2020)

Natural enemy	Population/20 complete sweeps				
	15 DAT	30 DAT	60 DAT	90 DAT	Mean
Hymenopterans wasps	3.61	7.00	14.55	6.72	8.93
Orthoptera grasshoppers	4.85	9.41	22.40	10.94	13.37
Odoneta flies	8.97	11.60	13.25	2.49	9.92
Hemipteran bugs	1.91	5.19	12.10	4.07	6.74
Spiders	0.00	0.00	10.17	11.67	6.82
Mean	3.87	6.64	13.91	7.18	9.16

DAT= date of transplanting

### CONCLUSION

The highest infestation of stem borer was observed in Mehandiwada village of Waraseoni and lowest in Belgoan village of Lallburra. The maximum percent damaged leaves was recorded in Bakoda and minimum was in Savngi village. The five natural enemies (hymenoptera wasp, meadow grasshopper, dragonfly and damselfly, hemipteran bugs and spider) were observed at different stages of crop growth. The *S. insertulas* and *C. medinalis* were predominant species of stem borer and leaf folder respectively, in rice ecosystem of Balaghat district. The peak activities of stem borers and leaf folders were recorded at tillering stage in 4<sup>th</sup> week of August and at panicle stage during 3<sup>rd</sup> week of September, respectively. The maximum activities of natural enemies were at vegetative and panicle stage of rice crop.

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