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The diversity and abundance of Lepidoptera pest in the Rice Fields of Sholavandan, Madurai District, Tamil Nadu, India

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ABSTRACT: A field observation was conducted to monitor the pest surveillance of paddy, which causes economic damage to the farmers. Lepidopteran pests such as Yellow stem borer, White stem borer, Cut worm, Case worm, and Armyworm are significant contributors to crop damage and yield loss. The study took place from October to March in 2021 and 2022, covering two seasons. Five fields located three kilometers apart were selected for the study. Insects were collected at fortnightly intervals, identified, and subjected to bio-monitoring. The analysis included the abundance richness, Shannon index, Simpson index, and evenness of Lepidopteran insects, comparing their diversity between the two seasons.

Keywords - Rice pests, *Scirpophaga incertulas*, *Nymphula depunctalis*, Diversity, indices.

Introduction

Rice holds the title of being the most crucial food crop in India, occupying approximately one-fourth of the total cropped area and serving as a staple for about half of the Indian population. Globally, there are around 10,000 varieties of rice, with approximately 4,000 of them being cultivated in India. The primary occupation of the residents in the Madurai district is agriculture, with the Vaigai river water being a significant resource. The Periyar water flows alongside the Mullai river in this district, ultimately reaching the Vaigai Dam. Paddy cultivation takes place twice a year. Throughout the ages, pests have been connected to crops. However, due to changing environmental conditions, their numbers have risen, with minor pests now emerging as major threats that cause extensive damage to crops. The heightened occurrence of pest-related diseases requires increased chemical application, resulting in higher input costs and disrupting agro-ecological equilibrium. Worldwide, over 10,000 insect species harm food plants (Dhaliwal *et al*., 2007)[1], with more than 100 species identified as rice crop pests, 20 of which hold economic importance (Banwo, 2002; Pathak M.D., 2011)[2, 15]. Stem borers are recognized as the most destructive pests of economic significance in rice. More than 800 insect species have been found to cause damage to either standing or stored rice. Oerke and Dehne (2004)[3] documented an actual loss of almost 40% due to insect pests in rice globally, with a potential total loss estimated to be between 65-80% of achievable yields. Despite the implementation of various control measures, managing agricultural pests remains a crucial challenge for farmers, with insect-related yield losses reaching up to 60-70%. In India, the agricultural sector is currently experiencing an annual loss of approximately Rs. 8,63,884 million due to insect pests. This substantial crop damage forces farmers to utilize large quantities of pesticides. With a high number of insect pests causing significant harm to both kharif and rabi crops, the present study conducted during 2021-22 aims to investigate the current occurrence of Lepidopteran infestations, infestation rates, and diversity in agricultural fields (kharif and rabi crops) of Sholavandan rice fields in Madurai District.

METERIALS AND METHODS

Five villages such as Alankottaram (S1), Rishabam (S2), Mannadimangalam (S3), Tiruvedakam (S4), and Nedunkulam (S5) were chosen for the analysis of pest population. The agricultural fields were visited twice a month, with sampling conducted in the morning hours (6:30 am to 9:30 am) and evening hours (4:30 pm to 6:30 pm). Collection methods included hand picking and sweep net method, with each quadrate being swept multiple times (10 sweeps per session, followed by a new set of 10 sweeps after a 10-minute interval). Large insects were killed using killing jars with potassium cyanide for storage and preservation, while small insects were preserved in glass vials containing 70-90% ethyl alcohol. Identification and labeling were done in the laboratory using the keys available in standard taxonomic literature and standard manuals.

RESULTS AND DISCUSSION

The evaluation of agricultural fields for the period 2021-22 revealed significant damage to economically important kharif and rabi crops by a variety of insect pests, particularly those belonging to the Lepidoptera order. These pests included the Leaf folder, Rice case worm, Rice horn caterpillar, Swarming caterpillar, Yellow stem borer, White stem borer, Cut worm, Army worm, and Yellow hairy caterpillar. Among the 5 fields examined in season 1, Tiruvedakam (S4) had the highest number of insects (435), followed by Mannadimangalam (S3) with 434, Nedunkulam (S5) with 412, Rishabam (S2) with 326, and Alankottaram (S1) with 273. In season 2, the number of Lepidopterans identified increased, with 846 observed in (S5) fields, 790 in (S4), 703 in (S3), 647 in (S2), and 611 in (S1). This data highlights the severity of the insect infestation and the potential impact on crop yields for the upcoming seasons.

Table 1: Number of Lepidopteran insects collected at different sites in season 1

S. No	Name of insect	Site1	Site2	Site3	Site4	Site5	total
1	Leaf folder	72	64	120	164	134	554
2	Rice case worm	19	36	55	61	31	202
3	Rice horn caterpillar	13	24	40	42	39	158
4	Swarming caterpillar	18	15	12	9	10	64
5	Yellow stem borer	33	38	54	34	36	195
6	White stem borer	18	15	12	9	10	64
7	Cut worm	39	38	54	34	36	195
8	Army worm	49	55	49	30	33	216
9	Yellow hairy caterpillar	6	19	23	15	18	80
	Total	**273**	**326**	**434**	**435**	**412**	**1880**

Table 2: Number of Lepidopteran insects collected at different sites in season 2

S. No	Name of insect	Site1	Site2	Site3	Site4	Site5	total
1	Leaf folder	97	107	116	157	134	611
2	Rice case worm	54	68	38	59	82	301
3	Rice horn caterpillar	32	51	46	13	21	163
4	Swarming caterpillar	91	77	77	108	116	469
5	Yellow stem borer	50	41	57	84	76	308
6	White stem borer	78	90	155	162	248	733
7	Cut worm	87	99	77	75	69	407
8	Army worm	36	48	54	48	49	235
9	Yellow hairy caterpillar	86	66	82	84	51	369
	Total	**611**	**647**	**702**	**790**	**846**	**3596**

Based on diversity indices, the richness in season 1 varies from 1.316 to 1.426 (R1) and 0.432 to 0.545 (R2). The Simpson index ranges from 0.120 to 0.160, the Shannon index ranges from 1.726 to 2.145, Hills diversity N1 ranges from 4.691 to 5.830, N2 ranges from 6.25 to 8.333 (Table 4). The evenness values vary from E1-0.749 to 0.936, E2—0.577 to 0.662, E3 – 0.524 to 0.620, E4—0.834 to 1.198, and E5 – 0.801 to 1.391 (Table 3). In the second season, the range of Richness varied from 1.186 to 1.247 (R1) and 0.309 to 0.544 (R2). The Simpson index showed variation from 0.120 to 0.160, while the Shannon index ranged from 1.726 to 2.145. Additionally, Hills diversity N1 varied from 4.691 to 5.830, and N2 varied from 6.25 to 8.333 (Table 4). The evenness values also showed variation, with E1 ranging from 0.703 to 0.802, E2 from 0.634 to 0.778, E3 from 0.003 to 0.703, E4 from 1.284 to 1.430, and E5 from 0.346 to 1.518 (Table 4). Comparison of two seasons shows that, In season 2, a higher number of insects (3596) were collected compared to season 1 (1880). Among the five selected sites, infestation levels increased from site 1 (273,611) to site 5 (412,846). This indicates that site 1 had the lowest infestation rate, while site 5 was highly affected by pests. Additionally, water irrigation commenced earlier in site 1 than in the other sites, particularly site 5. This suggests that the timing of water irrigation may have played a role in the differing infestation levels across the sites. It is possible that the earlier irrigation in site 1 created a less favorable environment for pests, while the delayed irrigation in site 5 may have allowed for a more conducive habitat for insects to thrive. This information could be valuable for future pest management strategies, as it highlights the potential impact of agricultural practices on pest infestation levels (Baba and Ohno, 2024; Chintalapati *et al*., 2023)[4,5]. Further research into the specific factors contributing to the varying infestation rates at each site could provide valuable insights for improving pest control measures in agricultural settings (Jiang *et al*., 2016; Kumari *et al*., 2023) [6, 16]. The abundance, richness, and diversity of insects in the paddy fields can be attributed to factors such as rainfall rate, wind flow, climatic conditions, and continuous cultivation (Fatima *et al*., 2021; Peng *et al*., 2024) [7,8]. The failure of crop rotation also played a role in this phenomenon. Biodiversity encompasses genetic species richness and ecosystem diversity, and it is believed that these elements are interconnected. This can be measured through taxonomy inventories conducted within specific areas (Fox and Rown tree, 2000; Groombridge and Jenkins, 2002) [9,10]. The diversity of species in a specific region is influenced by migration patterns, adaptation to environmental factors, and the subsequent impact on the ecosystem (Barbour *et al*., 1998) [11]. There is a notable correlation between rainfall and the abundance of insect fauna, despite the complexity of factors involved and the various ways in which weather conditions can affect each group differently (Pinheiro *et al*., 2002; Hmwe *et al*., 2020) [12, 13]. The presence of stem borers and white head damage occurrence remained unaffected by the application of insecticide spray across different rice varieties. This lack of impact may be attributed to factors such as the development of pest resistance resulting from prolonged use of a single insecticide for a specific type of insect, improper timing of application, and incorrect dosage due to insufficient understanding of pesticide application. Achieving control of stem borers with insecticides can prove to be challenging as the larvae and pupa of the borers complete their life cycles inside the stems. Furthermore, the overlapping population of these pests in the field complicates the timing of insecticide application for successful control (Wale *et al*., 2006) [14].

Table 3: Richness, diversity and evenness of lepidopteran in season 1

Parameters	S1	S2	S3	S4	S5
R1	1.426	1.382	1.317	1.316	1.328
R2	0.545	0.498	0.432	0.431	0.443
Simpson index	0.153	0.135	0.152	0.201	0.217
Shannon index	1.985	2.062	2.02	2.194	1.911
N1	5.396	5.605	5.49	5.963	5.194
N2	6.536	7.407	6.578	4.975	4.608
E1	0.767	0.936	0.775	0.812	0.749
E2	0.596	0.623	0.61	0.662	0.577
E3	0.549	0.575	0.561	0.620	0.524
E4	1.211	1.321	1.198	0.834	0.887
E5	1.260	1.391	1.242	0.801	0.860

Table 4: Richness, diversity and evenness of lepidopteran in season 2

Parameters	S1	S2	S3	S4	S5
R1	1.247	1.236	1.220	1.199	1.186
R2	0.364	0.544	0.339	0.320	0.309
Simpson index	0.123	0.120	0.132	0.140	0.160
Shannon index	2.127	2.145	2.1	2.046	1.726
N1	5.781	5.830	5.708	5.561	4.691
N2	8.130	8.333	7.57	7.142	6.25
E1	0.798	0.802	0.792	0.780	0.703
E2	0.642	0.647	0.634	0.778	0.750
E3	0.003	0.603	0.588	0.570	0.703
E4	1.406	1.430	1.326	1.284	1.332
E5	1.491	1.518	1.395	1.346	1.422

CONCLUSION

The emergence of insects is influenced by climatic conditions. In season 1, there is heavy wind and a rainfall rate of 143 in December, which restricts the appearance of pests. Farmers refrain from using pesticides during this time. On the other hand, season 2 experiences cold and dry weather (28-36) along with continuous cultivation, allowing insects to cause more infestation. The variety of suckers leads to "hopper burn" in many areas. The natural predators such as spiders, ladybird beetles, and limnogenous insects were also abundant during these seasons. In order to prevent crop loss, farmers resorted to using pesticides like Tricyclozole, Quinol, and Chorophos to manage the pests. Unfortunately, the pests reappeared after 15 to 30 days. Another contributing factor to their emergence is the continuous cultivation of rice without crop rotation, coupled with the application of fertilizers like potash, sulphate, and urea in different combinations, which contribute to the increase in paddy pests. Regarding water irrigation, early water supply in the first week of October in Sholavandan leads to earlier cultivation, resulting in lower pest surveillance compared to other sites where water is supplied in the third week of October or the first week of December, thus favoring pest emergence.

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Conflict of interest declaration

We certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript.

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