



Influence of climatic factors on the occurrence of major insect pests of rice in the coastal agro-ecosystem of Karaikal

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Abstract

Seasonal incidence of insect pests of rice was investigated during *Rabi* 2024–25 and Summer 2025 in Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal. Distinct seasonal peaks were observed, with major pests including thrips, yellow stem borer, leaf folder, planthoppers, leafhoppers, earhead bug, black bug and rice hispa showing higher incidence between 46th–52nd SMW (*Rabi*) and 15th–22nd SMW (Summer). Correlation analysis indicated that pest populations were significantly influenced by climatic factors. Thrips, leaf folder, and planthoppers showed significant associations with temperature, relative humidity, and rainfall, though the direction of relationships varied between seasons. Yellow stem borer, green leafhopper, earhead bug, black bug and rice hispa also exhibited significant weather-dependent incidence patterns. Multiple linear regression revealed that climatic variables explained 42–79 per cent of pest variability during *Rabi* and 53–81 per cent during Summer. These findings emphasize the role of weather parameters in shaping pest dynamics and support the development of climate-based pest management strategies in rice.

Keywords: Rice, insect pests, seasonal incidence, climatic factors, weather parameters, pest dynamics, integrated pest management

Introduction

Rice (*Oryza sativa* L.) is a primary staple crop that supports more than half of the world's population and plays a crucial role in ensuring food security, particularly in Asia. Despite advancements in cultivation practices and varietal improvement, rice productivity is significantly constrained by insect pests, which cause substantial quantitative and qualitative yield losses each year (Ali *et al.*, 2020; Demis 2025) [1, 7]. It is estimated that over 100 insect species infest rice ecosystems, of which approximately 15–20 species are considered economically important, including yellow stem borer (*Scirpophaga incertulas* Walker), brown planthopper (*Nilaparvata lugens* Stal), leaf folder (*Cnaphalocrocis medinalis* Guenee), and gall midge (*Orseolia oryzae* Wood-Mason) (Pathak and Khan 1994; Ali *et al.*, 2020) [1, 30]. The population dynamics and seasonal incidence of insect pests in rice are largely governed by prevailing climatic conditions. Key meteorological parameters such as temperature, relative humidity, rainfall, sunshine hours, and wind velocity have a direct and indirect influence on pest development, survival, fecundity, and dispersal (Narayanasamy *et al.*, 2017; Mohanta *et al.*, 2020) [23, 25]. Temperature, in particular, is considered a critical abiotic factor regulating insect metabolism and life cycle duration, thereby influencing the rate of population build-up and outbreak potential (Porter *et al.* 1991; Ali *et al.* 2020) [1, 31]. Similarly, relative humidity and rainfall play significant roles in determining pest abundance by affecting egg hatchability, larval survival, and host plant suitability (Mochida *et al.* 1987) [22]. In addition to direct effects, climatic factors also indirectly influence insect pest occurrence through their impact on crop growth stages, host plant physiology, and natural enemy activity. Variations in

weather parameters can alter plant phenology and nutritional quality, making crops more or less susceptible to pest attack (Fukaya *et al.*, 1971; Mohanta *et al.*, 2020) [8, 23]. Furthermore, changes in climatic conditions can disrupt ecological balance by affecting predator–prey interactions, thereby influencing pest outbreaks (Porter *et al.*, 1991) [31]. Recent evidence suggests that climate change, characterized by increasing temperatures, irregular rainfall patterns, and extreme weather events, has further intensified the incidence and distribution of insect pests in rice ecosystems. Such changes may lead to the expansion of pest geographical ranges, increased number of generations per year, and emergence of new pest complexes (Paramasiva *et al.*, 2024) [28]. These shifts pose a serious challenge to sustainable rice production and necessitate a better understanding of climate–pest relationships.

The coastal agro-ecosystem of Karaikal, located in the Union Territory of Puducherry, represents a unique rice-growing environment influenced by maritime climatic conditions, including high relative humidity, saline winds, and moderate to high temperatures. These factors create a favorable microclimate for the proliferation of several major insect pests, often resulting in severe infestations and economic losses. Despite its importance, limited information is available on the quantitative relationship between climatic variables and pest incidence in this region. Therefore, the present study was undertaken to investigate the influence of climatic factors on the occurrence of major insect pests of rice in the coastal agro-ecosystem of Karaikal. Understanding these relationships will aid in developing reliable pest forecasting models and location-specific integrated pest management (IPM) strategies for sustainable rice production.

Materials and Methods

The field investigation on the influence of climatic factors on the occurrence of major insect pests of rice was conducted during the *Kharif* and *Rabi* seasons at the Eastern Farm of Pandit Jawaharlal Nehru College of Agriculture and Research Institute (PAJANCOA and RI), Karaikal, Union Territory of Puducherry, India. Karaikal is located at 10.95° N latitude and 79.78° E longitude with an altitude of about 4 m above mean sea level and is characterized by a tropical coastal climate with high humidity and seasonal rainfall predominantly received through the northeast monsoon (Nishanthini and Kandibane, 2021) [26]. Rice variety CO 51 was cultivated following the recommended package of practices of the region except plant protection measures. Thirty-day-old seedlings were transplanted at a spacing of 15 × 10 cm under natural field conditions without insecticidal application to facilitate natural pest incidence. Similar experimental procedures for rice pest incidence studies were followed by Ashrith *et al.* (2018) and Kalita *et al.* (2020) [1, 2]. Observations on the incidence of major insect pests *viz.*, yellow stem borer, *S. incertulas*, leaf folder, *C. medinalis*, brown planthopper, *N. lugens*, and green leafhopper, *N. virescens*, were recorded at weekly intervals from transplanting to harvest. For stem borer incidence, percent dead hearts during vegetative stage and white ears during reproductive stage were recorded from ten randomly selected hills. Leaf folder damage was assessed based on percent damaged leaves, whereas hopper population was recorded as number of insects per hill from randomly selected hills, following the standard methodologies adopted in rice ecosystem studies (Kalita *et al.*, 2020; Kumar *et al.*, 2023) [1, 17] (Plate 1 to 4). Meteorological parameters including maximum temperature (°C), minimum temperature (°C), morning relative humidity (%), evening relative humidity (%), rainfall (mm), and sunshine hours were obtained from the agrometeorological observatory located adjacent to the experimental field. Weekly mean values of weather parameters corresponding to pest observation periods were computed for analysis. The relationship between weather parameters and pest incidence was analyzed using Pearson's correlation analysis to determine the influence of climatic factors on pest occurrence. Regression analysis was also performed to evaluate the degree of association between climatic variables and insect pest population dynamics. Statistical analyses were carried out using standard statistical procedures as described by Gomez and Gomez (1984) [10].

Results and Discussion

Seasonal incidence of major insect pests of rice was studied during Rabi 2024–25 and Summer 2025 [11, 34] (Table 1; Fig. 1). Thrips appeared during the early crop stage in both seasons. During Rabi, infestation commenced in the 44th SMW (14 thrips/20 seedlings) and peaked in the 46th SMW (46 thrips/20 seedlings) before declining by the 48th SMW. In Summer, incidence started in the 13th SMW (39 thrips/20 seedlings), reached a peak in the 15th SMW (57 thrips/20 seedlings), and declined thereafter. Similar early-season occurrence of rice thrips was reported by Kumar *et al.* (2012a) and Begam *et al.* (2016) [4]. Yellow stem borer (YSB) larvae first appeared during the 48th SMW in Rabi and reached peak incidence during the 1st–2nd SMW (45–50 larvae/50 hills), followed by a decline towards the 5th SMW. In Summer, infestation began in the 16th SMW and

peaked during the 19th SMW (44 larvae/50 hills). These findings corroborate earlier reports of peak stem borer activity during May and early summer crop stages (Mahadevan and Chelliah, 1986; Pallavi *et al.*, 2018; Balaji and Vijaykumar, 2025) [3, 19, 27]. Leaf folder infestation was first observed during the 45th SMW in Rabi and attained maximum incidence during the 50th SMW (89 larvae/50 hills). In Summer, infestation started in the 14th SMW and peaked during the 20th SMW (33 larvae/50 hills). Earlier observations by Murali (2016), Tiwari *et al.* (2021), and Jadhao (2024) [12, 24, 39] support the present findings. Minor defoliators such as horned caterpillar, skipper, eupterotid hairy caterpillar, and yellow hairy caterpillar were recorded with low population levels in both seasons. Similar seasonal occurrence of skipper and horned caterpillar was earlier documented by Subhash Chander (1998) [38].

Among sap-feeding pests, green leafhopper (GLH) appeared during the 46th SMW in Rabi and the 15th SMW in Summer, with peak incidence during the 51st SMW (70 nos./50 hills) and 20th SMW (59 nos./50 hills), respectively. Brown planthopper (BPH) incidence during Rabi commenced in the 46th SMW and peaked during the 52nd SMW (75 nos./50 hills). White-backed planthopper (WBPH) appeared during the 45th SMW and attained maximum incidence in the 48th SMW (32 nos./50 hills), whereas white leafhopper occurred in low numbers from the 48th to 5th SMW. The occurrence of GLH and WBPH during November–January agrees with the reports of Sabale *et al.* (2010) [35], Sarkar *et al.* (2018b), and Nishanthini and Kandibane (2021) [26]. Higher incidence of hopper pests during December–January was associated with cloudy weather, rainfall, and reduced sunshine. Earhead bug incidence commenced during the 50th SMW in Rabi and the 18th SMW in Summer, reaching peak populations during the 2nd SMW (111 bugs/50 hills) and 22nd SMW (308 bugs/50 hills), respectively. Similar seasonal incidence was reported by Das *et al.* (2023) and Giri and Mohapatra (2024) [9]. Rice hispa infestation appeared during the 46th SMW in Rabi and the 15th SMW in Summer, with peak activity during the 1st and 18th SMW, respectively, corroborating the findings of Deka *et al.* (2000) and Choudhary (2001) [5, 6]. Black bug incidence was observed only during Summer 2025, appearing in the 15th SMW and peaking during the 17th SMW (42 bugs/50 hills), which agrees with the findings of Mathirajan *et al.* (2017) [21]. Overall, pest incidence varied with season and crop stage, with higher activity of stem borer, leaf folder, hoppers, and earhead bug during reproductive stages of the crop.

Correlation analysis between meteorological parameters and major rice pests during Rabi 2024 [11]–25 and Summer 2025 is presented in Table 2 and Fig. 2. Thrips population showed a significant positive correlation with minimum temperature ($r = 0.41$) and evening relative humidity (RH) ($r = 0.44$), and a significant negative correlation with morning RH ($r = -0.40$) during Rabi. In Summer, thrips exhibited significant negative correlations with maximum temperature ($r = -0.33$), minimum temperature ($r = -0.30$), and rainfall ($r = -0.36$), while showing a significant positive correlation with morning RH ($r = 0.50$). Similar relationships were reported by Rajpoot *et al.* (2024), and Raval *et al.* (2025) [32, 34]. Yellow stem borer (YSB) showed a significant negative correlation with maximum temperature ($r = -0.34$) during Rabi, whereas in Summer it exhibited a significant negative correlation with evening RH ($r = -0.18$). Other weather

parameters showed non-significant associations. These findings are in agreement with Balaji and Vijaykumar (2025), Patel and Singh (2017), and Jasrotia *et al.* (2019) [3, 14, 29]. Leaf folder incidence exhibited a significant negative correlation with maximum temperature ($r = -0.63$) and a significant positive correlation with evening RH ($r = 0.40$) during Rabi. In Summer, leaf folder population showed significant positive correlations with minimum temperature ($r = 0.41$) and rainfall ($r = 0.60$), while correlations with RH remained non-significant. Similar observations were made by Kavadi *et al.* (2022) and Rautaray *et al.* (2020) [16, 33]. Green leafhopper (GLH) population had a significant negative correlation with maximum temperature during both Rabi ($r = -0.54$) and Summer ($r = -0.44$). During Summer, GLH also showed a significant positive correlation with minimum temperature ($r = 0.55$). Earlier studies by Mahajan and Kumar (2025) [20], and Kakde *et al.* (2015) reported comparable trends.

Brown planthopper (BPH) exhibited a significant negative correlation with maximum temperature ($r = -0.51$) and a significant positive correlation with morning RH during Rabi 2024–25. Positive associations with rainfall were also observed. These findings corroborate reports by Anand *et al.* (2023), Jadhao and Salve (2021), Shelke *et al.* (2025), and Sarkar *et al.* (2018a). Earhead bug population showed a significant negative correlation with rainfall ($r = -0.44$) during Rabi. In Summer, significant negative correlations were observed with morning RH ($r = -0.42$) and evening RH ($r = -0.50$), while maximum and minimum temperatures exhibited significant positive correlations ($r = 0.57$ and 0.43 , respectively). Similar results were reported by Soneshwar *et al.* (2024) [37], Vinothkumar (2015), and Das *et al.* (2023) [17]. Rice hispa recorded a significant negative correlation with maximum temperature during Rabi, whereas in Summer it showed a significant positive correlation with minimum temperature ($r = 0.56$). Other weather parameters exhibited non-significant associations. These findings are in

accordance with Japur (2016) and Harika *et al.* (2024) [11, 13]. Overall, maximum temperature exerted a predominantly negative influence on most rice pests, whereas minimum temperature, relative humidity, and rainfall variably influenced pest incidence depending on the pest species and season.

The multiple linear regression analysis indicated that all the weather parameters together was responsible for significant variation of 42, 52, 79, 65, 66, 56 and 57 per cent on the incidence of thrips, yellow stem borer, leaf folder, green leafhopper, brown planthopper, earhead bug and hispa beetle population respectively, in rice during Rabi 2024 [11]-25 and significant variation of 60, 54, 56, 81, 53 and 68 per cent on the incidence of thrips, yellow stem borer, leaf folder, green leafhopper, earhead bug and hispa beetle population respectively, in rice during Summer 2025 (Table 3).

Conclusion

The present investigation revealed distinct seasonal patterns in the incidence of major insect pests of rice during Rabi 2024–25 and Summer 2025 [11, 34] in the coastal agro-ecosystem. Thrips predominated during the early crop stage, whereas yellow stem borer, leaf folder, hopper pests, earhead bug, and rice hispa attained higher populations during the reproductive stage of the crop. Summer season generally recorded higher pest incidence compared to Rabi, particularly for earhead bug, thrips, and black bug. Correlation analysis indicated that meteorological parameters significantly influenced pest dynamics. Maximum temperature exerted a predominantly negative effect on most pests, while minimum temperature, relative humidity, and rainfall showed variable influences depending on pest species and season. The study highlights the importance of seasonal monitoring and weather-based pest forecasting for timely implementation of integrated pest management strategies in rice ecosystems.

Table 1: Seasonal incidence of rice insect pests during Rabi 2024-25 and Summer 2025 (Weekly average)

Meteorological Standard Week (MSW)	Rice pests*												
	Thrips	Yellow stem borer	Leaf folder	GLH	BPH	WBPH	WLH	Earhead bug	Hispa	Black bug	Rice horned caterpillar	Rice skipper	Hairy caterpillars
Rabi 2024-25													
43 rd (Oct 22-28)	0	0	0	0	0	0	0	0	0	0	0	0	0
44 th (Oct 29-Nov 04)	14	0	0	0	0	0	0	0	0	0	0	0	0
45 th (Nov 05-11)	29	0	5	0	0	5	0	0	0	0	0	0	0
46 th (Nov 12-18)	46	0	27	9	15	11	0	0	5	0	0	0	0
47 th (Nov 19-25)	34	0	48	29	27	18	0	0	12	0	0	0	0
48 th (Nov 26-Dec 02)	17	9	59	31	39	32	3	0	16	0	0	0	0
49 th (Dec 03-09)	0	13	62	55	52	28	5	0	21	0	0	0	0
50 th (Dec 10-16)	0	26	89	62	59	21	12	24	30	0	2	0	0
51 st (Dec 17-23)	0	35	51	70	61	14	10	40	32	0	5	1	2
52 nd (Dec 24-31)	0	43	38	52	75	11	6	95	35	0	8	3	4
1 st (Jan 01-07)	0	45	24	41	43	7	4	104	45	0	6	5	3
2 nd (Jan 08-14)	0	50	18	24	27	3	6	111	20	0	2	2	3
3 rd (Jan 15-21)	0	37	13	18	25	0	8	71	12	0	0	1	1
4 th (Jan 22-28)	0	28	9	5	17	0	2	30	0	0	0	0	0
5 th (Jan 29-Feb 04)	0	12	0	0	0	0	4	12	0	0	0	0	0
6 th (Feb 05-11)	0	0	0	0	0	0	0	0	0	0	0	0	0
7 th (Feb 12-18)	0	0	0	0	0	0	0	0	0	0	0	0	0
Summer 2025													
12 th (Mar 19-25)	0	0	0	0	0	0	0	0	0	0	0	0	0
13 th (Mar 26-Apr 01)	39	0	0	0	0	0	0	0	0	0	0	0	0
14 th (Apr 02-08)	45	0	2	0	0	0	0	0	0	0	0	0	0
15 th (Apr 09-15)	57	0	7	5	0	0	0	0	9	21	0	0	0

16 th (Apr 16-22)	40	24	12	7	0	0	0	0	13	34	0	0	0
17 th (Apr 23-29)	16	32	40	26	0	0	0	0	34	42	0	1	0
18 th (Apr30-May06)	0	15	38	42	0	0	0	29	39	30	1	2	0
19 th (May 07-13)	0	44	25	50	0	0	0	50	20	26	2	2	3
20 th (May 14-20)	0	22	33	59	0	0	0	107	19	14	2	1	4
21 st (May 21-27)	0	18	24	43	0	0	0	200	12	7	2	1	4
22 nd (May28-June3)	0	12	51	23	0	0	0	308	8	0	1	0	2
23 rd (Jun 04-10)	0	8	13	12	0	0	0	95	0	0	0	0	1
24 th (Jun 11-17)	0	0	0	0	0	0	0	29	0	0	0	0	0
25 th (Jun 18-24)	0	0	0	0	0	0	0	0	0	0	0	0	0
26 th (Jun 25-Jul 01)	0	0	0	0	0	0	0	0	0	0	0	0	0

*Wet palm method (30 wet palm taps/20 seedlings): thrips *Sweep net (50 sweeps/50 hills): thrips, GLH, BPH, WBPH, WLH, hispa beetle, earhead bug, black bug
 *Direct count on hills/ panicles: yellow stem borer larvae, leaf folder larvae, hispa beetle, earhead bug, black bug, rice horned caterpillar, rice skipper larvae and hairy caterpillar

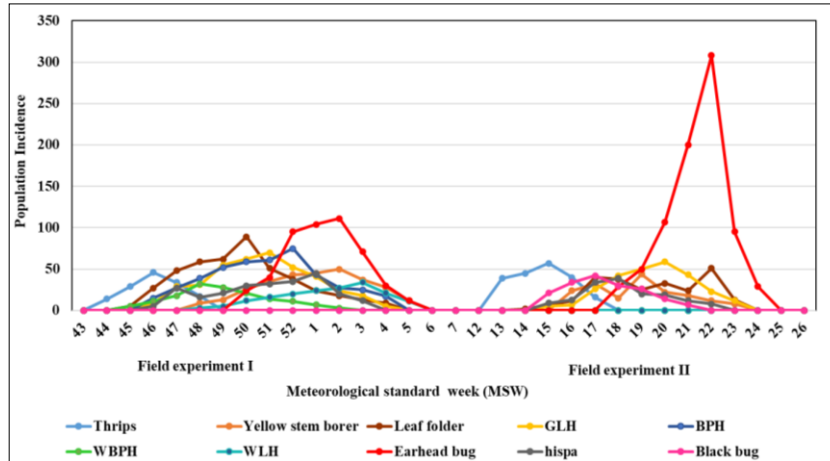


Fig 1: Incidence of rice insect pests during Rabi 2024-25 and Summer 2025 (Field experiment I and II)

Table 2. Correlation between meteorological parameters and the population of rice pests during Rabi 2024-25 and Summer 2025

Sl. No.	Insects	Rabi 2024-25					Summer 2025				
		Temperature (°C)		Relative humidity (%)		Rainfall (mm)	Temperature (°C)		Relative humidity (%)		Rainfall (mm)
		Maxi.	Mini.	Morning	Evening		Maxi.	Mini.	Morning	Evening	
1.	<i>S. biformis</i>	-0.12	0.41*	-0.40*	0.44*	-0.54	-0.33*	-0.30*	0.50**	0.25	-0.36*
2.	<i>S. incertulas</i>	-0.34*	-0.20	0.02	0.05	-0.22	-0.54	0.44	-0.19	-0.18*	0.56
3.	<i>C. medinalis</i>	-0.63*	0.33	-0.11	0.40*	0.62	0.54	0.41*	-0.13	-0.20	0.60*
4.	<i>N. virescens</i>	-0.54*	0.16	0.01	0.25	0.23	-0.44*	0.55**	-0.18	-0.10	0.01
5.	<i>N. lugens</i>	-0.51*	0.18	0.08*	0.21	0.23	-	-	-	-	-
6.	<i>L. acuta</i>	-0.15	-0.52	0.01	0.03	-0.44*	0.57*	0.43*	-0.42*	-0.50*	0.30
7.	<i>D. armigera</i>	-0.04**	0.09	0.02	-0.16	-0.11	-0.33	0.56*	-0.02	0.19	-0.06

* Significance at 0.05 per cent level** Significance at 0.01 per cent level

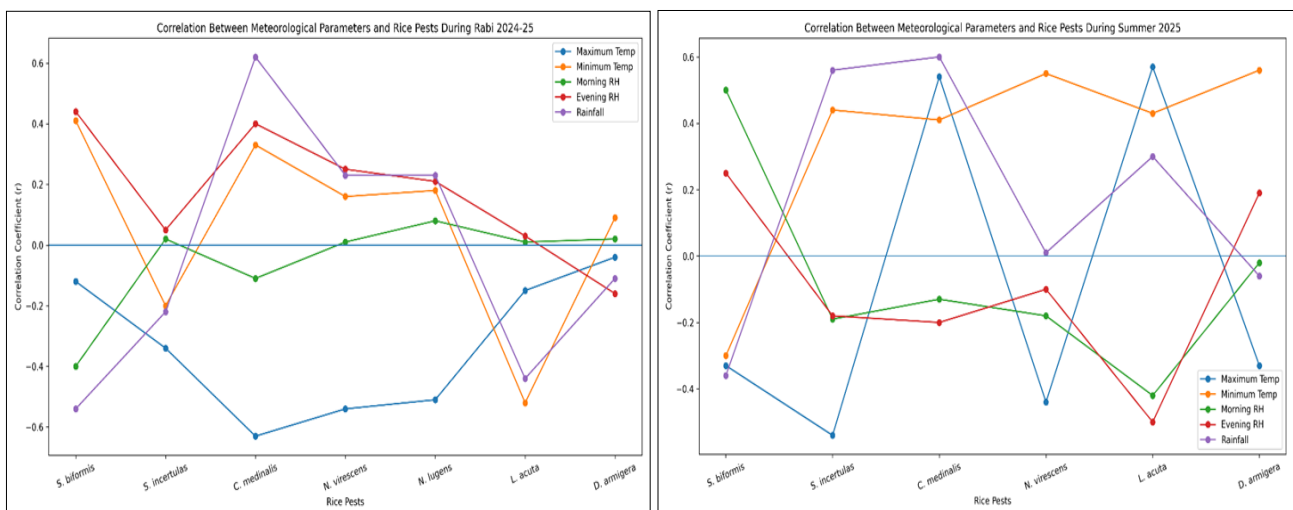


Fig 2: Correlation between meteorological parameters and the population of rice pests during Rabi 2024-25 and Summer 2025

Table 3: Multiple linear regression between meteorological parameters and the population of rice pests during *Rabi* 2024-25 and Summer 2025

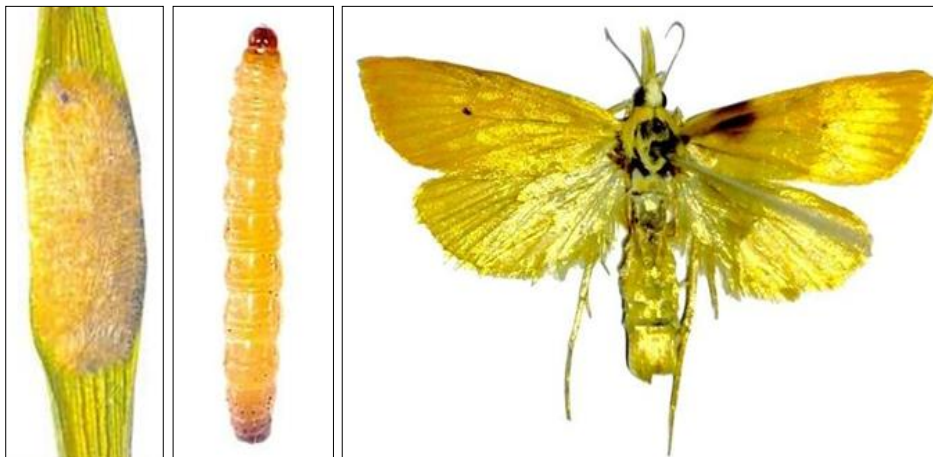
Sl. No.	Variables(Y)	<i>Rabi</i> 2024-25		Summer 2025	
		Regression equation	R ² value	Regression equation	R ² value
1.	<i>S. biformis</i>	$Y = -43.55 + 4.04X_1 + 0.21X_2 - 1.75X_3 + 0.99X_4 + 0.43X_5$	0.42	$Y = -417.79 + 5.36X_1 - 3.32X_2 + 5.03X_3 - 1.74X_4 - 5.76X_5$	0.60*
2.	<i>S. incertulas</i>	$Y = 513.11 - 14.32X_1 + 4.04X_2 - 1.05X_3 - 0.41X_4 - 1.03X_5$	0.52*	$Y = -209.79 - 1.42X_1 + 10.03X_2 + 0.36X_3 - 0.30X_4 + 4.80X_5$	0.54*
3.	<i>C. medinalis</i>	$Y = 177.09 - 23.04X_1 + 11.70X_2 + 5.14X_3 - 2.32X_4 + 0.21X_5$	0.79**	$Y = -598.27 + 3.58X_1 + 11.68X_2 + 0.79X_3 + 1.80X_4 + 0.50X_5$	0.56*
4.	<i>N. virescens</i>	$Y = 64.52 - 25.15X_1 + 13.40X_2 + 5.99X_3 - 1.40X_4 - 0.86X_5$	0.65**	$Y = -467.64 - 0.20X_1 + 15.91X_2 + 2.39X_3 - 2.02X_4 - 0.51X_5$	0.81**
5.	<i>N. lugens</i>	$Y = 74.16 - 18.78X_1 + 9.67X_2 + 4.61X_3 - 1.47X_4 - 0.52X_5$	0.66**	-	
6.	<i>L. acuta</i>	$Y = 1068.28 - 7.19X_1 - 8.24X_2 - 9.08X_3 + 3.13X_4 - 2.03X_5$	0.56*	$Y = -281.75 - 6.27X_1 + 36.87X_2 + 2.70X_3 + 10.15X_4 + 12.76X_5$	0.53*
7.	<i>D. armigera</i>	$Y = 231.29 - 14.39X_1 + 6.58X_2 + 1.83X_3 - 1.07X_4 - 0.54X_5$	0.57*	$Y = -607.58 + 4.13X_1 + 11.05X_2 + 0.66X_3 + 2.07X_4 - 0.10X_5$	0.68**

* Significance at 0.05 per cent level ** Significance at 0.01 per cent level
 X₁ - Maximum temperature (°C) X₂ - Minimum temperature (°C)
 X₃ - Morning relative humidity (%) X₄ - Evening relative humidity (%)
 X₅ - Rainfall (mm)

Plate 1: Pests of rice at PAJANCOA and RI, Karaikal, U.T. of Puducherry



The thrips, *Stenchaetothrips biformis* (Bagnall)

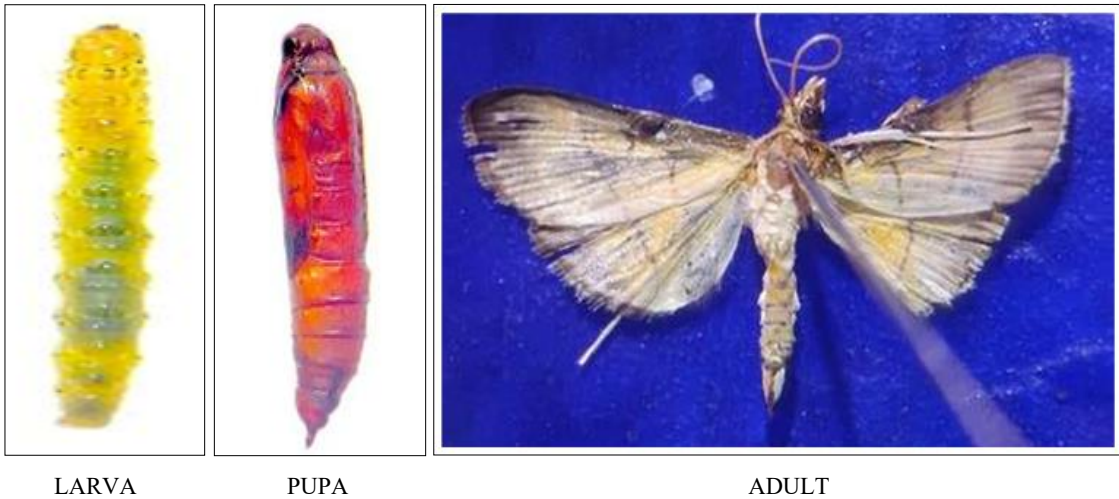


EGG MASS

LARVA

ADULT

The yellow stem borer, *Scirpophaga incertulas* (Walker)



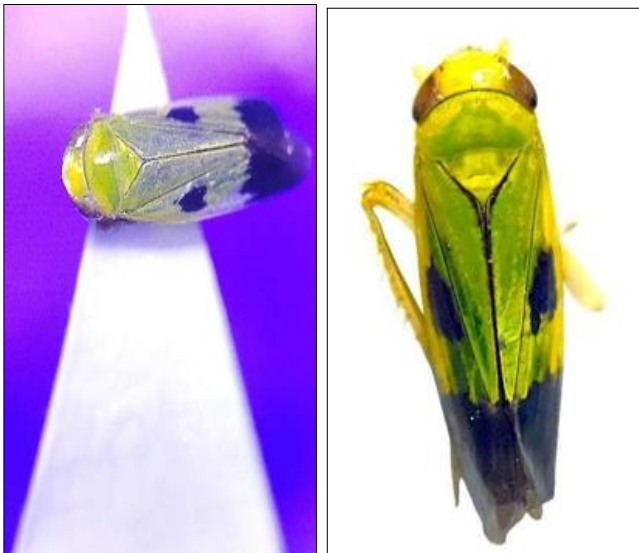
LARVA

PUPA

ADULT

The leaf folder, *Cnaphalocrocis medinalis* (Guenee)

Plate 2: Pests of rice at PAJANCOA and RI, Karaikal, U.T. of Puducherry



The green leafhopper, *Nephotettix virescens* (Distant)



The white backed planthopper, *Sogatella furcifera* (Horvath)

Plate 3: Pests of rice at PAJANCOA and RI, Karaikal, U.T. of Puducherry



The brown planthopper, *Nilaparvata lugens* (Stal.)



The white leafhopper, *Cofana spectra* (Distant)



The earhead bug, *Leptocorisa acuta* (Thunberg)

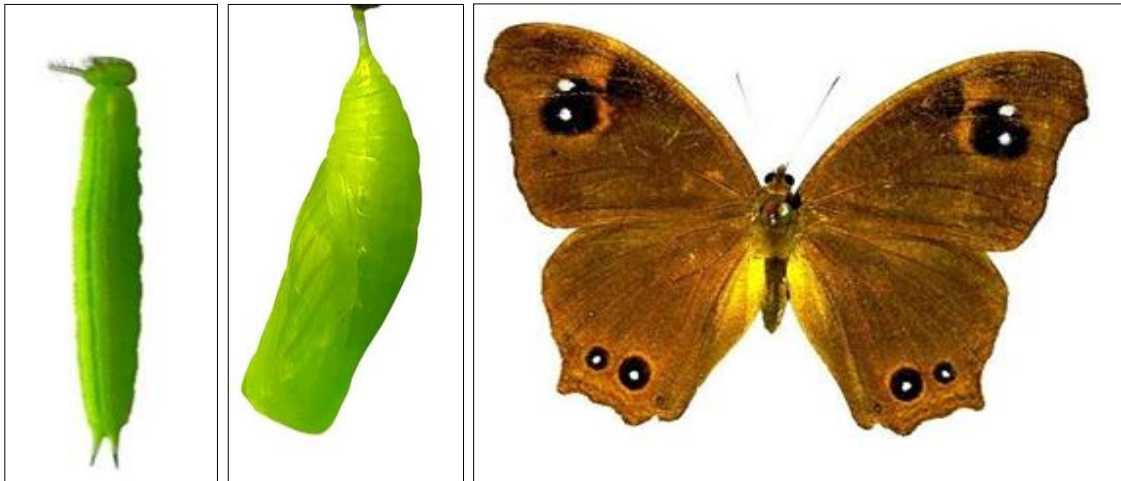


The hispa, *Dicladispa armigera* (Oliver)



The black bug, *Scotinophora lurida* (Burmeister)

Plate 4: Pests of rice at PAJANCOA and RI, Karaikal, U.T. of Puducherry



LARVA

PUPA

ADULT

The rice horned caterpillar, *Melanitis leda ismene* (Cramer)



LARVA

PUPA

ADULT

The rice skipper, *Pelopidas mathias* (Fabricius)



The Eupterotid hairy caterpillar, *Euproctis virguncula* (Walker)



The yellow hairy caterpillar, *Psalis pennatula* (Fabricius)

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