Indian Journal of Agricultural Sciences **96** (2): 256–259, February 2026/Short Communication
https://doi.org/10.56093/ijas.v96i2.158256

Evaluation of BIPM vis-a-vis farmer practices on rice (*Oryza sativa*) insect-pests in relation to weather parameters in the *Tarai* region of Uttarakhand

RIYA[1]* and R P MAURYA[1]

College of Agriculture, Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, Uttarakhand 263 145, India

Received: 15 October 2024; Accepted: 27 January 2026

Keywords: Bio-intensive pest management, Benefit cost ratio, Insect-pests, Weather parameters

Rice (*Oryza sativa* L.), a crucial cereal crop for over three billion people, belongs to the family Poaceae. India is the world's second-largest producer after China (Ganguli *et al.* 2020). Total production of rice during 2020–21 is estimated at record of 121.46 million tonnes (MoA&FW 2021). Major rice-producing states include West Bengal, Uttar Pradesh, Punjab, Andhra Pradesh, Chhattisgarh, and Uttarakhand (NFSM 2021), with Uttarakhand contributing 482.00 thousand tonnes in 2021 (DoA&C 2021). Rice production is influenced by biotic and abiotic factors, with insects being the most significant biotic factor in affecting crop yield. More than 100 insect species have been identified as pests of rice, including the yellow stem borer [*Scirpophaga incertulas* (Walker)], rice leaf folder [*Cnaphalocrocis medinalis* (Guenee)], brown plant hopper [*Nilaparvata lugens* (Stal)], white backed plant hopper [*Sogatella furcifera* (Horvath)], and Gandhi bug (*Leptocorisa acuta*) (Atwal and Dhaliwal 2008). The yellow stem borer (YSB), a monophagous and highly destructive pest of rice from the family Crambidae, is one of the most serious pests to rice production. Another major pest, the rice leaf folder, also belonging to Crambidae, causes damage when second instar larvae fold leaves and feed on mesophyll tissues, resulting in a yield loss of about 20–30%. The brown plant hopper (BPH) of the family Delphacidae feeds by sucking sap from plant tissues and can cause severe wilting symptoms known as “hopper burn”. Collectively, insect-pests contribute to approximately 27.9% yield loss in rice (Mondal *et al.* 2017). Synthetic pesticides are the most often used technique to manage these insect-pests. However, the excessive and indiscriminate use of pesticides has contaminated the environment and affected the health of non-target organisms, including humans. Increasing awareness about safe and environment-friendly food has promoted the adoption of bio-based and sustainable farming practices. With the growing demand for residue-free produce, a Bio-Intensive Pest Management (BIPM) module was compared with farmers’ practices plots (FPP) in rice during 2021 at Pantnagar, situated in the *Tarai* region, of the Shivalik range of the Central Kumaon Himalayas.

The study was carried out during the rainy (*kharif*) season of 2021 (June to October, 2021) at the Norman E. Borlaug Crop Research Centre, Govind Ballabh Pant University of Agriculture and Technology, Pantnagar (29° N, 79° E; at an elevation of 243.8 m amsl), Uttarakhand to compare rice BIPM modules with farmers' practices using the Pusa Basmati 1509 rice variety. Based on the data collected during the field experiment conducted in 2021, a comprehensive integrated crop management module was developed. The module comprised of BIPM modules including (1) Rice seedlings were root-treated with Pant Bioagent-3 at 10 g/L of water for 30 min prior to transplanting to manage seedling pests; (2) Border crops such as sunhemp, sesame, cucurbits, okra, zinnia and marigold were raised; (3) Azadirachtin (1500 ppm) @3 mL/L was applied for the management of foliar sucking pests; (4) Pheromone traps were installed at 20 traps/ha for mass trapping of male yellow stem borer adults and lures changed after 15 days interval; (5) *Trichogramma japonicum* was released at 100,000 eggs/ha against *S. incertulas* every 10 days interval; and Farmers’ practice modules, viz. (1) Seed treatment with carbendazim 50% WP at 2 g/kg of seed; (2) Application of chlorantraniliprole 0.4% GR at 10 kg/ha at 25 days after transplanting against yellow stem borer and leaf folder; (3) Spraying of fipronil 5% SC at 1.2 L/ha at the panicle initiation stage against yellow stem borer and sucking pests (brown plant hopper); (4) Application of chlorantraniliprole 18.5% SC at 150 mL/ha against yellow stem borer and leaf folder; (5) Spraying of propiconazole 250 EC at 500 g/ha; and (6) Installation of 5 pheromone traps/ha in farmers’ fields for monitoring of male yellow stem borer adults adults and lures changed after 15 day interval. Data on pest incidence and natural enemy populations were

[1]College of Agriculture, Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, Uttarakhand. *Corresponding author email: nautiyal.riya9991@gmail.com

collected from BIPM and FPP. Weekly observations of pheromone traps, dead heart and white ear head caused by yellow stem borer, brown plant hopper, and leaf folder, as well as natural enemy population dynamics, were recorded starting from the 33rd Standard Meteorological Week (15–21 August 2021) from a 1 m² area of the rice field. The dead heart and white ear head were computed by using following formula (Chaturvedani *et al.* 2020):

$$\text{Deadheart (\%)} = \frac{\text{Number of dead hearts}}{\text{Total number of tillers}} \times 100$$

$$\text{White ear head (\%)} = \frac{\text{Number of white ear heads}}{\text{Total number of tillers}} \times 100$$

The study recorded grain yield, cultivation cost, and net profit in BIPM modules and farmer plots, C:B ratio were analysed using Paired-t test (Gomez and Gomez 1984) and SPSS 21 statistical software for correlation analysis.

Pest incidence: The data on the effects of BIPM practices on YSB in rice plots compared to FPP revealed that the incidence of YSB began at the 33rd Standard Meteorological Week (vegetative stage), with the highest mean population recorded in FPP (0.29 ± 0.25) and the lowest in the BIPM plot (0.28 ± 0.24) (Table 1). Similar observations were reported by Anitha and Parimala (2014), who noted that stem borer infestation initiated at 15 days after transplanting (DAT) and persisted until crop maturity, reaching peak levels during October.

Brown plant hopper incidence was observed to be highest in FPP (2.19 ± 0.84 nymphs and adults/hill), whereas the lowest population was recorded in BIPM plots (1.33 ± 0.51 nymphs and adults/hill). These findings are consistent with the results reported by Kumar and Sarada (2016), who documented reduced BPH infestation in BIPM plots (4.6–9.6/10 hills) compared to substantially higher levels in non-BIPM plots (10.2–21.1/10 hills). Rice leaf folder (LF) infestation was lower in BIPM plots (0.52 ± 0.29 LF/m²) compared to farmer's practice plots (0.70 ± 0.35 LF/m²), indicating effective suppression of pest populations under BIPM practices. These results were

Table1 Comparison of populations of pests and their natural enemies in BIPM and FPP during *kharif* season 2021

Standard weeks (Plant stage)	Mean number of insect-pests and natural enemies											
	YSB/m²		BPH/hill		Leaf folder/m²		Damselfly/m²		Spider/m²		Dragonfly/m²	
	BIPM Plot	FPP	BIPM Plot	FPP	BIPM Plot	FPP	BIPM plot	FPP	BIPM Plot	FPP	BIPM plot	FPP
33 (Vegetative Stage)	0.10 ± 0.22	0.13 ± 0.13	1.00 ± 0.61	2.70 ± 0.86	0.10 ± 0.22	0.26 ± 0.14	1.00 ± 0.35	0.33 ± 0.23	1.70 ± 0.75	0.33 ± 0.23	0.90 ± 0.22	0.13 ± 0.18
34 (Vegetative Stage)	0.20 ± 0.27	0.13 ± 0.18	1.00 ± 0.35	2.90 ± 0.79	0.10 ± 0.22	0.33 ± 0.23	0.80 ± .27	0.20 ± 0.18	1.80 ± 0.83	0.40 ± 0.14	1.10 ± 0.41	0.20 ± 0.29
35 (Reproductive Stage)	0.20 ± 0.27	0.20 ± 0.18	1.20 ± 0.83	2.80 ± 1.06	0.20 ± 0.27	0.40 ± 0.14	1.10 ± 0.22	0.26 ± 0.14	2.00 ± 0.50	0.33 ± 0.30	0.80 ± 0.67	0.13 ± .18
36 (Reproductive Stage)	0.30 ± 0.27	0.26 ± 0.27	1.10 ± 0.41	3.00 ± 0.98	0.30 ± 0.27	0.40 ± 0.29	1.00 ± 0.35	0.33 ± 0.00	1.90 ± 0.40	0.26 ± 0.14	0.50 ± 0.35	0.53 ± 0.18
37 (Reproductive Stage)	0.40 ± 0.22	0.46 ± 0.18	1.30 ± 0.27	3.20 ± 0.98	0.20 ± 0.27	0.46 ± 0.27	1.20 ± 0.27	0.40 ± 0.14	2.00 ± 0.50	0.33 ± 0.00	0.60 ± 0.22	0.20 ± 0.29
38 (Reproductive Stage)	0.40 ± 0.22	0.53 ± 0.18	1.10 ± 0.41	3.20 ± 1.10	0.46 ± 0.38	0.20 ± 0.27	1.10 ± 0.22	0.33 ± 0.23	2.10 ± 0.54	0.40 ± 0.14	0.80 ± 0.27	0.26 ± 0.43
39 (Reproductive Stage)	0.50 ± 0.35	0.53 ± 0.18	1.10 ± 0.89	3.20 ± 1.10	0.46 ± 0.38	1.20 ± 0.44	1.30 ± 0.57	0.70 ± 0.27	1.10 ± 0.22	0.60 ± 0.23	0.72 ± 0.27	0.13 ± 0.18
40 (Ripening Stage)	0.60 ± 0.41	0.66 ± 0.62	3.30 ± 0.44	1.73 ± 0.49	1.80 ± 0.44	0.90 ± 0.54	1.00 ± 0.35	0.33 ± 0.23	1.20 ± 0.57	0.26 ± 0.26	0.68 ± 0.41	0.26 ± 0.14
41 (Ripening Stage)	0.30 ± 0.44	0.26 ± 0.27	0.20 ± 0.27	0.26 ± 0.27	0.26 ± 0.27	1.60 ± 0.82	1.20 ± 0.90	0.40 ± 0.14	1.00 ± 0.35	0.33 ± 0.23	0.85 ± 0.27	0.20 ± 0.29
42 (Ripening Stage)	0.00 ± 0.00	0.00 ± 0.00	2.30 ± 0.75	2.13 ± 1.67	1.93 ± 0.82	2.00 ± 0.79	1.10 ± 0.41	0.26 ± 0.14	1.10 ± 0.41	0.40 ± 0.27	0.30 ± 0.44	0 ± 0.00
43 (Ripening Stage)	0.00 ± 0.00	0.00 ± 0.00	1.10 ± 0.41	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	1.10 ± 0.22	0.33 ± 0.23	2.10 ± 0.54	0.40 ± 0.14	0.80 ± 0.27	0.26 ± 0.43
Average	0.28 ± 0.24	0.29 ± 0.25	1.33 ± 0.51	2.19 ± 0.84	0.52 ± 0.29	0.70 ± 0.35	1.08 ± 0.41	0.35 ± 0 .19	1.63 ± 0 .51	0.36 ± 0 .18	0.71 ± 0 .33	0.68 ± 0 .23
Paired t test	−0.857		−2.283		−1.054		26.77		8.89		6.92	
Remarks	NS		S*		NS		S**		S**		S**	

BIPM, Bio-intensive pest management; FPP, Farmer's practices plot; YSB, Yellow stem borer; BPH, Brown plant hopper. S*, Mean values differ significantly at 5% level of significance based on paired t-test (p<0.05); S**, Mean values differ significantly at 1% level of significance based on paired t-test (p<0.01); NS, Non-significant (p> 0.05).

found slightly similar with Lyla *et al.* (2010), who reported lower leaf folder incidence (0.54%) under BIPM compared to 0.96% in non-BIPM plots based on pooled data analysis over three years.

In the present study, the cumulative mean population of damselflies was higher in BIPM plots (1.08 ± 0.41/m²) than in FPP (0.35 ± 0.19/m²). Similar observations were reported by Sharma *et al.* (2018), who recorded a greater damselfly population in BIPM plots (4.50/plot) compared to FPP (3.88/plot). Spiders effectively reduce pest density on rice fields by attacking soft-bodied insects, with the highest activity observed in the BIPM plot (1.63 ± 0.51 spider/m^2) and the lowest in the FPP (0.36 ± 0.18 spider/m^2). The current findings match with Ganguli *et al.* (2020), who also reported higher spider populations in BIPM plots (0.35 and 0.41) than in FPP plots (0.18 and 0.23) during 2018 and 2019, respectively. Further, the cumulative mean population of dragonflies was slightly higher in BIPM plots (0.71 ± 0.33/m²) compared to FPP plots (0.68 ± 0.23/m²). Similar observations were reported by Sharma *et al.* (2018), who found a higher mean dragonfly population in BIPM plots (0.75/plot) than in FPP plots (0.38/plot).

Correlation coefficient between insect-pests and natural enemies of rice with weather parameters data: The correlation with maximum temperature found to have a positively significant correlation with YSB (0.65*), damselfly (0.714*) at BIPM plot. While, in FPP, maximum temperature had a positively significant correlation with YSB (0.639*), damselfly (0.785**). At the BIPM plot, minimum temperature was positive correlation with BPH (0.816**), dragonfly (0.748**), damselfly (0.620*), spider (0.773**). In BIPM plot, minimum RH have a positively significant correlation with BPH (0.717*) and positively non-significant correlation with damselfly (0.405), spider (0.605), negatively non-significant with YSB (-0.049), LF (-0.437). Rainfall showed a non-significant correlation with insect-pests and natural enemies at BIPM and FPP. Sunshine had a positively significant correlation with dragonfly (0.619*) at BIPM plot. While in FPP, sunshine had non-significant correlation with insect-pests and natural enemies (Fig. 1).

Percent damage due to yellow stem borer and yield and benefit-cost ratio in Pusa Basmati 1509 in BIPM and FP plot: The data indicated that dead heart (DH) damage was higher in the BIPM plot (1.25%) compared to the FPP plot (0.80%), whereas white ear head (WEH) damage was higher in FPP (8.18%) and lower in BIPM (6.22%) (Table 2). These findings are supported by Chaturvedani *et al.* (2020), who reported significantly lower DH damage (8.50%) and WEH damage (15.58%) in BIPM-treated plots compared to farmer's practice plots, which recorded 11.24% DH and 18.01% WEH.

Grain yield: The aggregated yield data showed lower grain yield in the FPP plot (21.7 q/ha), while the maximum yield was recorded in the BIPM plot (32.12 q/ha), along with an additional border crop yield of 3.12 q/ha. Similar findings were reported by Lyla *et al.* (2010) who observed higher rice yield under BIPM (6969.3 kg/ha) compared to non-IPM plots (6094.0 kg/ha) during 2007–08, indicating

Table 2 Yield and benefit-cost ratio in Pusa Basmati 1509 in BIPM and FP plot

Treatments	% DH	% WEH	Yield (q/ha)	Border crop yield (q/ha)	Gross return (₹)	Cost of cultivation (₹)	Net return (₹)	C:B ratio
BIPM	1.25	6.22	29	3.12	64460	28847	33613	1:2.24
FPP	0.80	8.18	21.7	0	42098	31250	10848	1:1.35

BIPM, Bio-intensive pest management; FPP, Farmer's practices plot; DH, Dead heart; WEH, White ear head; C:B ratio, Cost-benefit ratio.

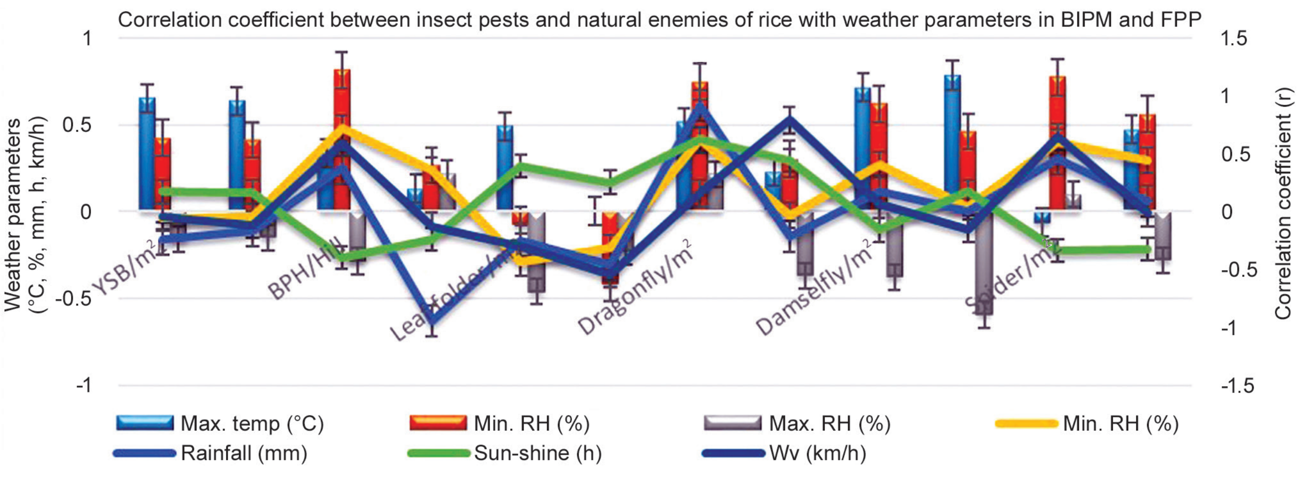

Fig. 1 Correlation coefficient between insect-pests and natural enemies of rice with weather parameters.
** Correlation is significant at the 0.01 level, * Correlation is significant at the 0.05 level. BIPM, Bio-intensive pest management; FPP, Farmer's practices plot; RH, Relative humidity; YSB, Yellow stem borer; BPH, Brown plant hopper.

that overall crop health improvement under BIPM plays a major role in yield enhancement.

Cost-benefit ratio: The cost-benefit ratio analysis indicated that the highest C:B ratio (1:2.24) was recorded in the BIPM plot, whereas the lowest (1:1.35) was observed under farmer's practice (FPP) (Table 2). These findings are supported by Kumar and Sarada (2016) who reported a comparatively higher cost-benefit ratio in BIPM plots (1:2.04) than in non-BIPM plots (1:1.71).

SUMMARY

The experiment was conducted during the rainy (*kharif*) season of 2021 (June to October, 2021) at the Norman E. Borlaug Crop Research Centre, Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, Uttarakhand to compare Bio-Intensive Pest Management (BIPM) practices with farmer's practices (FP) in rice. BIPM included green manuring, transplanted border crops, seed treatment, pheromone traps, augmentative releases of *Trichogramma japonicum*, and spraying of 1% neem oil, whereas FP mainly depends on chemical insecticides. BIPM plots recorded lower incidences of yellow stem borer (YSB), brown plant hopper (BPH), and leaf folder, along with higher populations of natural enemies. Although BIPM plots showed slightly higher dead hearts, they had fewer white ear heads, higher grain yield, and a better cost-benefit ratio compared to FPP. Correlation studies revealed a significant positive relationship between YSB incidence and maximum temperature. While BPH was positively correlated with minimum temperature and relative humidity in BIPM plots, predator species such as dragonflies and damselflies also showed a positive correlation with minimum temperature in BIPM plots. The above information showed that BIPM packages and frequently pest monitoring have significantly reduced insect-pests and increased natural enemies in BIPM fields compared to FPP. Green manuring increases crop nutrients availability, reducing the need for additional nitrogen treatment. Seed treatment with PBA-3 eliminated bacterial and fungus diseases in BIPM plots. BIPM offers a superior benefit-cost ratio, boosting crop production and maintaining ecological balance. It is economically more affordable, suppresses major insect-pests and supports sustainable farming practices.

REFERENCES

Anitha G and Parimala K. 2014. Evaluation of bio-intensive pest management (BIPM) package in rice varieties as an effective means to tackle stem borer. *Plant Archives* **14**(1): 185–87.

Atwal A S and Dhaliwal G S. 2008. *Agriculture Pests of South India and their Management*, pp. 616. Kalyani Publishers, Ludhiana, Punjab, India.

Chaturvedani J, Ganguli J and Gauraha R. 2020. Bio-intensive pest management against yellow stem borer, *Scirpophaga incertulus* Walker at Raipur, Chhattisgarh. *Journal of Entomology and Zoology Studies* **8**(4): 943–46.

DoA&C. 2021. *Total Rice Production in Uttarakhand*. Department of Agriculture and Cooperation. https://www.ceicdata.com (Accessed on 9/2/2022)

Ganguli J, Gauraha R, Nagdev P and Chaturvedani J. 2020. Evaluation of bio-intensive pest management (BIPM) module in rice var. Swarna at Raipur, Chhattisgarh. *Biological Control* **34**(4): 281–87.

Gomez K A and Gomez A A. 1984. *Statistical Procedures for Agricultural Research*, pp. 128. Wiley International publication, London, UK.

Kumar G S and Sarada O. 2016. Evaluation of bio-intensive pest management module against insect pest complex of rice. *Andhra Pradesh Journal of Agricultural Sciences* **2**(1): 42–47.

Lyla K R, Beevi S P, Philip B M and Jalali S K. 2010. Biological control of rice pests in 'Kole' lands of Kerala. *Journal of Biological Control* **24**(3): 268–70.

MoA&FW. 2021. Ministry of Agriculture and Farmers' Welfare, Government of India. https://pib.gov.in (Accessed on 9/2/2022).

Mondal D, Ghosh A, Roy D, Kumar A, Shamurailatpam D, Bera S and Majumder A. 2017. Yield loss assessment of rice (*Oryza sativa* L.) due to different biotic stresses under system of rice intensification (SRI). *Applied Entomology and Zoology* **5**(4): 1974–80.

NFSM. 2021. National Food Security Mission. https://www.nfsm.gov.in (Accessed on 11/2/2022).

Sharma S, Shera P S and Sangha K S. 2018. Impact of bio-intensive integrated pest management practices on insect pests and grain yield in basmati rice. *Biological Control* **32**(2): 137–41.