D-6252
[1-7]

RESEARCH ARTICLE Agricultural Science Digest

Performance of Various Pesticides Against Yellow Stem Borer, *Scirpophaga incertulas* (Walker) of Basmati Rice and Effect on Yield in Northern India

Sushant Kumar[1,2], Hem Singh[1], D.V. Singh[1], Shankar Dayal Bharti[3],
Chandan Kumar Panigrahi[4], Ankit Rai[5]

10.18805/ag.D-6252

ABSTRACT

Background: Rice (*Oryza sativa Linn.*) is a staple food crop that sustains billions of people worldwide, especially in Asia, where it provides a significant portion of daily caloric intake. It grows across diverse climates, from tropical to temperate regions and at varying elevations. India is well-known for its aromatic basmati rice, valued for its unique fragrance and quality.

Methods: Investigation conducted during the *Kharif-2018* at C.R.C. of S.V.P. University of Ag. and Tech., Meerut, utilizing RBD with 9 treatments which were replicated thrice including control. Twenty-five-day-old Pusa Basmati-1 seedlings were transplanted into 5 × 4 m² plots. Treatments were applied twice during peak pest populations using a knapsack sprayer with a hollow cone nozzle.

Result: In the field different insect pest was occurred *i.e. Scirpophaga incertulas, Cnaphalocrocis medinalis*, *Nilaparvata lugens* and others. Among all the treatments, Fipronil 5 SC was the most effective after that Imidacloprid 17.8 SC and C. hydrochloride 4G. In the bio-pesticide category, *Beauveria bassiana* was the most effective followed by *Metarhizium anisopliae* and *Verticillium lecanii*. Fipronil treatment yielded the highest grain production (38.35 q/ha), while Imidacloprid produced 37.26 q/ha.

Key words: Dead heart, Insect fauna, Pesticides, Rice, Treatments, Yellow stem borer and yield.

INTRODUCTION

Rice (*Oryza sativa* Linn.), a vital cereal from the Poaceae family, is essential for global nutrition, especially in Asia, where it provides up to 80% of daily calories for over two billion people. human being throughout the world which can be cultivated in wide range of agro-climate zone of India as well as world (Kumar *et al.,* 2024). In India, rice is grown across 44.5 million hectares, producing about 115.63 million tons (Anonymous, 2019). This versatile crop thrives in tropical, subtropical and temperate zones, growing as far north as 43°N and south to 39°S and at elevations reaching 2,500 meters. Rice varieties are broadly categorized as aromatic and non-aromatic. India's basmati rice, known for its characteristic fragrance, is mainly grown in Haryana, Punjab, Uttarakhand and western Uttar Pradesh. The aroma is particularly notable during harvest, storage and cooking (Kumar and Singh, 2020; Bharti *et al.,* 2018). Besides its culinary appeal, rice holds nutritional value: 100 grams of rice provides 365 kcal, 7.12 grams of protein, 1.3 grams of fibers and small amounts of essential nutrients like thiamine, riboflavin, zinc, calcium, iron and manganese (Anonymous, 2010).

Increasing rice productivity is crucial to meet the food needs of a growing population. However, productivity faces challenges from insect pests, diseases and weeds, all of which reduce crop yields (Kumar *et al.,* 2019). Research and management strategies are essential to overcome these challenges and maintain rice as a reliable global food source. The yellow stem borer (*Scirpophaga incertulas* Walker) is a major pest in rice farming and is responsible for substantial economic losses, affecting rice crops from the seedling stage to harvest. In India, annual rice production losses due to insect pests are estimated at 55.12 million rupees, which accounts round 18.16% of total production losses. Out of this, the yellow stem borer alone is responsible for 20-30% of the damage (Lal, 1996). Among various constraints of rice production, the insect-

[1]Department of Entomology, Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut-250 110, Uttar Pradesh, India.
[2]Faculty of Agricultural Sciences, G.L.A. University, Mathura-281 406, Uttar Pradesh, India.
[3]Department of Ag. Ext. and Comm., Dr. K.N. Modi University, Newai-304 021, Rajasthan, India.
[4]Department of Entomology, Faculty of Agricultural Sciences, Siksha 'O' Anusandhan, Deemed to be University, Bhubneswar-751 003, Odisa, India.
[5]Department of Entomology, Acharya Narendra Deva University of Agriculture and Technology, Ayodhya-224 229, Uttar Pradesh, India.

Corresponding Author: Sushant Kumar, Department of Entomology, Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut-250 110, Uttar Pradesh, India.
Email: ksushant020@gmail.com

How to cite this article: Kumar, S., Singh, H., Singh, D.V., Bharti, S.D., Panigrahi, C.K. and Rai, A. (2025). Performance of Various Pesticides Against Yellow Stem Borer, *Scirpophaga incertulas* (Walker) of Basmati Rice and Effect on Yield in Northern India. Agricultural Science Digest. 1-7. doi: 10.18805/ag.D-6252.

Submitted: 21-11-2024 **Accepted:** 30-04-2025 **Online:** 16-06-2025

pests are of prime importance. Disease and insect-pests are estimated to cause yield losses to the tune of 30-40 per cent (Pandey and Choubey, 2012).

The use of insecticides is a common and highly effective strategy for managing pests among Indian rice farmers, particularly against destructive pests like the yellow stem borer. Chemical control is a fundamental component of Integrated Pest Management (IPM), a framework that also incorporates biological and cultural control methods to sustainably manage pest populations. However, the indiscriminate use of chemical pesticides has led to several negative outcomes, including a reduction in the biodiversity of natural predators, the emergence of secondary pest outbreaks and environmental contamination, highlighting the importance of careful pesticide selection and application (Singh, 2000).

To address these challenges, ongoing research has focused on evaluating the efficacy of both chemical and biological control methods against the yellow stem borer, aiming to identify pest management strategies that are effective while minimizing ecological disruption. By prioritizing options that align with sustainable pest management practices, this research aims to support agricultural productivity while safeguarding human, animal and environmental health.

MATERIALS AND METHODS

The field experiment was conducted at the crop research centre (CRC) of S.V.P. University during the *Kharif* season of 2018. Located at 29°04′ N latitude, 77°42′ E longitude and an altitude of 237 meters above mean sea level (MSL), the experimental site provided suitable conditions for this study on the Pusa Basmati-1 rice variety. The experiment was set up in a randomized block design (RBD) comprising nine treatments and three replications, along with an untreated control. 25 days-old seedlings were transplanted into main plots measuring 5×4 m².

All treatments were applied twice during peak pest populations: the first application was made 50 days after transplanting, followed by a second application 82 days after transplanting. Applications were carried out using a knapsack sprayer equipped with a hollow cone nozzle. Details of the treatments are summarized in Table 1. Pre-treatment observations were recorded one day before the first application, with data collected from ten randomly selected hills in each plot. Post-treatment observations were recorded on the 3rd, 7th and 10th days after each application, focusing on the number of dead hearts in selected hills, calculated using the formula provided by Chatterjee and Mondal (2014).

For grain yield assessment, the weight of both healthy and damaged grains was recorded from each plot and converted to quintals per hectare (q/ha). The cost-benefit ratio of each treatment was also calculated. Statistical analysis was conducted using the analysis of variance (ANOVA) technique for randomized block design, following the methods outlined by Panse and Sukhatme (1978). Data transformations were applied when necessary to meet statistical assumptions. The software "OPSTAT1," developed by O.P. Sheoran (2004), was used for data analysis.

RESULTS AND DISCUSSION

Insect fauna associated with basmati rice

Throughout the study, a variety of insect species were identified as pests of rice crops, each exhibiting unique damage characteristics, seasonal abundance patterns and economic significance. A total of thirteen insect species

Table 1: Treatment details.

Treatment no.	Name of treatment with formulation	Trade name	Dose	Source
T_1	Imidacloprid 17.8 SC	Immediate	200 ml/ha	BR Agrotech Ltd., Rajendra Place, New Delhi
T_2	Thiamethoxam 25 WG	Savor	100 gm/ha	Coromandal Agrico pvt. Ltd., Sikandrabad,U.P.
T_3	Fipronil 5 SC	Regent SC	1000 ml/ha	Bayer crop-science Ltd., Bari Brahmana, J. and K.
T_4	Lambda cyhalothrin 5 EC	Lambda gold	500 ml/ha	Indian crop chemical pvt Ltd., East Mumbai, Maharastra
T_5	Cartap hydrochloride 4 G	Vat 4G	750 gm *a.i.*/ha	Meghmani Organics Ltd., Bharuch, Gujrat
T_6	*Beauveria bassiana* 2×10^9 c.f.u./gm	-	2.5 kg/ha	Biocontrol laboratory of S.V.P.U.A. and T. Modipuram, Meerut
T_7	*Metarhizium anisopliae* 4.7×10^8 c.f.u./gm	-	2.5 kg/ha	Biocontrol laboratory of S.V.P.U.A. and T.Modipuram, Meerut
T_8	*Verticellium lacani* 2×10^8 c.f.u./ml	Green Verticill	2.5 l./ha	Greenlife Biotech Laboratory, Coimbatore, Tamil Nadu
T_9	Untraeated	-	-	-

were documented attacking rice at various growth stages in Meerut, Uttar Pradesh, as detailed in Table 2. These species-initiated infestations around 20 days after transplanting, marking a critical period for implementing pest management strategies to minimize impacts on crop yield and quality. This knowledge of the timing and nature of infestations enables farmers to apply timely and effective control measures to safeguard their crops.

Efficacy of insecticides on yellow stem borer after first spray

Pre-treatment observations

Before the application of treatments, pre-treatment observations indicated that the percentage of "dead hearts" in the field ranged from 5.79% to 6.49% across the study plots. Statistical analysis showed that this variation in pre-treatment damage was not significant across treatments, suggesting a relatively uniform pest presence and damage level throughout the field. These baseline observations are summarized in Table 3.

Post-treatment observations

Three days after spray application

Three days after spraying, all treatments showed significantly greater efficacy compared to the untreated control, with chemical pesticides demonstrating the highest reduction in damage from *Scirpophaga incertulas*. The lowest damage was observed in plots treated with Fipronil 5 SC (5.21%), which was significantly more effective than Imidacloprid 17.8 SC (5.51%) and Cartap hydrochloride 4 G (5.62%). Among the bio-pesticides, *Beauveria bassiana* and *Metarhizium anisopliae* were the most effective, reducing damage levels to 6.14% and 6.29%, respectively, while the untreated control exhibited the highest damage at 6.53%. These results are consistent with the findings of Kakde and Patel (2019), who reported that Cartap hydrochloride 4 G was less effective than Fipronil in managing yellow stem borer infestations. This conclusion is further supported by Singh *et al.* (2017) and Lal (2006).

Seven days after spray application

After seven days, Fipronil 5 SC continued to provide the best control, achieving the lowest damage level of 3.29%. Imidacloprid 17.8 SC followed with 3.95% damage and Cartap hydrochloride 4 G recorded 4.69%. Other effective treatments included Lambda cyhalothrin 5 EC (5.00%) and Thiamethoxam 25 WG (5.25%). Among bio-pesticides, the order of effectiveness was *Beauveria bassiana* (5.61%), *Metarhizium anisopliae* (5.96%) and *Verticillium lecanii* (6.07%), while the untreated control again showed the highest damage at 6.68%.

Table 2: Insect fauna recorded on basmati rice during *Kharif*, 2018.

Order	Family	Common name	Scientific name	Damaging stage of the insect	Economic status
Lepidoptera	Pyralidae	Yellow stem borer	*Scirpophaga incertulas* Walker	Larvae	Severe
	Pyralidae	Leaf folder	*Cnaphalocrosis medinalis* Guenee	Larvae	Severe
	Noctuidae	Swarming caterpillar (Army worm)	*Spodoptera mauritia* Boisduval	Larvae	Low
	Pyralidae	Rice case worm	*Nymphula depunctalis* Guenee	Larvae	Low
Homoptera	Cecadellidae	Green leaf hopper	*Nephotettix virescens* Distant	Nymphs and adults	Low
	Delphacidae	Brown plant hopper	*Nilaparvata lugens* Stal	Nymphs and adults	Moderate
	Delphacidae	White backed plant hopper	*Sogatella furcifera* Horvath	Nymphs and adults	Low
Hemiptera	Coreidae	Rice gundhi bug	*Leptocorisa acuta* Thumb	Nymphs and adults	Moderate
Coleoptera	Curculionidae	Rice root weevil	*Echinocnemus oryzae* Marshall	Grubs and adults	Low
	Curculionidae	White grub	*Holotrichia consanguinea* Blanch	Grubs and adults	Low
Isoptera	Termitidae	Termite	*Odontotermes obesus* Romb	Workers	Low
Orthoptera	Acrididae	*Kharif* grass hopper	*Hieroglyphus banian* Fab	Nymphs and adults	Low
	Acrididae	Grass hopper	*Oxya fuscovittata* Marshall	Nymphs and adults	Low

Table 3: Effect of treatments against yellow stem borer, *Scirpophaga incertulas* (Walker) following first application.

Treatment	Treatments with formulation	Dose/ha	Dead Heart (%) after 1st spray				Reduction over control (%)		
			DBS	3 DAS	7 DAS	10 DAS	3 DAS	7 DAS	10 DAS
T_1	Imidacloprid 17.8 SC	200 ml/ha	6.28	5.51	3.95	2.99	4.99	3.84	2.40
			(14.50)	(13.57)	(11.46)	(9.95)	(12.89)	(11.28)	(8.77)
T_2	Thiamethoxam 25 WG	100 gm/ha	5.99	5.84	5.25	4.33	5.37	4.58	3.62
			(14.15)	(13.97)	(13.23)	(11.98)	(13.96)	(12.35)	(10.96)
T_3	Fipronil 5 SC	1000 ml/ha	6.19	5.21	3.29	2.37	4.86	3.31	2.03
			(14.40)	(13.17)	(10.45)	(8.78)	(12.72)	(10.45)	(8.18)
T_4	Lambda cyhalothrin 5 EC	500 ml/ha	5.92	5.70	5.00	3.94	5.14	4.30	3.47
			(14.07)	(13.80)	(12.91)	(11.44)	(13.09)	(11.94)	(10.72)
T_5	Cartap hydrochloride 4 G	750 gm *a.i.*/ha	6.33	5.62	4.69	3.79	5.05	4.09	3.03
			(14.56)	(13.68)	(12.50)	(11.21)	(12.96)	(11.63)	(10.00)
T_6	*Beauveria bassiana*	2.5 kg/ha	5.79	6.14	5.61	4.51	5.40	4.96	3.95
	2×10^9 c.f.u./gm		(13.92)	(14.33)	(13.67)	(12.24)	(13.43)	(12.86)	(11.45)
T_7	*Metarhizium anisopliae*	2.5 kg/ha	6.49	6.29	5.96	4.71	5.49	5.13	4.13
	4.7×10^8 c.f.u./gm		(14.76)	(14.51)	(14.12)	(12.49)	(13.55)	(13.05)	(11.73)
T_8	*Verticellium lacani*	2.5 l./ha	5.84	6.35	6.07	5.94	5.86	5.30	4.42
	2×10^8 c.f.u./ml		(13.94)	(14.58)	(14.25)	(14.10)	(14.00)	(13.30)	(12.13)
T_9	Control		6.38	6.53	6.68	6.81	7.61	7.88	8.14
			(14.62)	(14.80)	(14.97)	(15.12)	(16.00)	(16.29)	(16.57)
	SEm(±)		0.31	0.32	0.31	0.44		0.30	0.47
	CD at 5%		N/A	0.92	0.94	1.36		0.91	1.42

Figures in parentheses are angular transformed value.

DBS= Day before spray; DAS= Days after spray.

Ten days after spray application

Ten days after the application, all treatments remained significantly more effective than the untreated control. Chemical pesticides consistently demonstrated strong efficacy, with Cartap hydrochloride 4 G (3.79%), Lambda cyhalothrin 5 EC (3.94%) and Thiamethoxam 25 WG (4.33%) performing particularly well. Among bio-pesticides, *Verticillium lecanii* (5.94%) was the least effective; however, *Beauveria bassiana* and *Metarhizium anisopliae* continued to show promising results, reducing damage to 4.51% and 4.71%, respectively. These findings align with the observations of Sulagitti *et al.* (2017) and Kumar and Kumar (2017), who identified *B. bassiana* and *M. anisopliae* as effective bio-pesticides for controlling yellow stem borer infestations.

Efficacy of insecticides on yellow stem borer after second spray

Three days after spray application

After three days following the second spray, observations confirmed a consistent trend: All treatments significantly outperformed the untreated control. The plots treated with Fipronil 5 SC demonstrated the best performance, exhibiting the lowest percentage of dead hearts at 4.86%, which was statistically comparable to Imidacloprid 17.8 SC at 4.99%. Among the bio-pesticides, *Verticillium lecanii* was the least effective, showing 5.86% dead hearts.

Seven days after spray application

On the seventh day of the study, various insecticide treatments were ranked for their effectiveness against the Yellow Stem Borer, *S. incertulas*. Fipronil 5 SC was the most effective, with a damage level of 3.31%, followed by Imidacloprid 17.8 SC at 3.84%. Cartap Hydrochloride 4 G showed a damage percentage of 4.09%, while Lambda Cyhalothrin 5 EC had 4.30%. Thiamethoxam 25 WG recorded the highest damage at 4.58%. The untreated plot suffered the most damage, underscoring the critical need for pest management. These results highlight Fipronil and Imidacloprid as superior choices for effective pest control.

Ten days after spray application

By the tenth day post-application, Fipronil 5 SC continued to be the most effective treatment, yielding only 2.03% dead hearts, followed closely by Imidacloprid 17.8 SC at 2.40%, which was statistically comparable to other high-performing treatments. These observations align with the findings of Suri and Makkar (2016), who noted that after seven days, Cartap hydrochloride exhibited minimal damage by the yellow stem borer, comparable to lots treated with Fipronil.

In the final observations taken at ten days after application, Fipronil 5 SC remained the best treatment, followed by Imidacloprid 17.8 SC. The subsequent order of effectiveness included Cartap hydrochloride 4 G (3.03%), Lambda cyhalothrin 5 EC (3.47%), Thiamethoxam 25 WG (3.62%), *B. bassiana* (3.95%), *M. anisopliae* (4.13%) and *V. lecanii* (4.42%). The untreated control recorded the highest damage level at 8.14%.

In this investigation, Fipronil 5 SC was established as the most effective treatment against damage caused by the yellow stem borer. This finding is consistent with the results of Seni and Naik (2017) and Katel *et al.* (2023), who also identified Fipronil 5 SC as the most effective, followed by Imidacloprid. Additionally, *V. lecanii* demonstrated promising results comparable to those of *M. anisopliae*. Current and previous studies corroborate

Table 4: Yield and economics of different treatments.

Treatment no.	Treatments name	Dose/ha	Yield of grains (q/ha)	Value of increased yield over control (Rs./ha)	Additional cost of treatments (Rs./ha)	Additional net profit (Rs./ha)	Cost benefit ratio
T_1	Imidacloprid 17.8 SC	200 ml/ha	37.26	31,980	3,620	28,360	1:7.83
T_2	Thiamethoxam 25 WG	100 gm/ha	36.05	28,350	3,300	25,050	1:7.59
T_3	Fipronil 5 SC	1000 ml/ha	38.35	35,250	4,600	30,650	1:6.66
T_4	Lambda cyhalothrin 5 EC	500 ml/ha	33.12	19,560	3,625	15,935	1:4.39
T_5	Cartap hydrochloride 4 G	750 gm/ha	33.87	21,810	3,310	18,500	1:5.59
T_6	*Beauveria bassiana* 2×10^9 c.f.u./gm	2.5 kg/ha	36.03	28,290	5,000	23,290	1:4.65
T_7	*Metarhizium anisopliae* 4.7×10^8 c.f.u./gm	2.5 kg/ha	34.65	24,150	5,000	19,150	1:3.83
T_8	*Verticellium lacani* 2×10^8 c.f.u./ml	2.5 lt./ha	32.51	17,730	5,000	12,730	1:2.55
T_9	Control	-	26.60	-	-	-	-

Labour charge @ Rs. 450.0/day.

Sale price of product @ Rs. 3,000/q.

Charges of sprayer @ Rs. 50/day.

the effectiveness of these treatments. Furthermore, Fipronil 0.3% GR and Cartap hydrochloride were identified as the next most effective insecticides, aligning with the findings of Panda *et al.* (2004), Roshan (2006) and Singh *et al*. (2010).

Cost-benefit analysis of treatments

The total expenses incurred during the experiment included costs for insecticides, seeds, labor and irrigation charges. The increase in income resulting from the applied treatments was assessed based on the corresponding rice yields. The highest yield was recorded in plots treated with Fipronil 5 SC, achieving 38.35 q/ha, followed closely by Imidacloprid 17.8 SC at 37.26 q/ha. The cost-benefit ratios calculated for each treatment are presented in Table 4.

All treated plots yielded significantly higher production, ranging from 32.53 q/ha to 38.35 q/ha, compared to the untreated control, which produced only 26.60 q/ha. The cost-benefit ratio for Imidacloprid 17.8 SC was 1:7.83, followed by Thiamethoxam 25 WG at 1:7.59 and Fipronil 5 SC at 1:6.66. While Fipronil 5 SC provided the highest yield in terms of quintals per hectare, its ranking in cost-effectiveness was lower due to its higher associated costs. Conversely, Cartap hydrochloride 4 G and Lambda cyhalothrin 5 EC exhibited lower yields, which could be attributed to their effectiveness against other insect pests, such as the brown plant hopper (BPH), Gall Midge and white plant hopper (WPH).

From the study, the treatment with Imidacloprid 17.8 SC at 200 ml/ha not only yielded higher grain production but also resulted in greater net profit, corroborating the findings of Sangamithra *et al.* (2018) and Mishra *et al.* (2009). The best cost-benefit ratio was recorded for Imidacloprid 17.8 SC at 200 ml/ha (1:7.83), closely followed by Thiamethoxam 25 WG at 100 gm/ha (1:7.59). This finding aligns partially with the results reported by Kumar and Kumar (2017).

CONCLUSION

During the study conducted in Meerut, Uttar Pradesh, thirteen insect species were identified as pests of rice, including *Scirpophaga incertulas* and *Nilaparvata lugens*, with infestations beginning 20 days after transplanting. In terms of insecticide efficacy, pre-treatment observations revealed a dead heart rate ranging from 5.79% to 6.49%, indicating no significant damage across treatments. Post-treatment results demonstrated that *Fipronil 5 SC* was the most effective, reducing damage to 5.21%, outperforming *Imidacloprid* 17.8 SC (5.51%) and Cartap hydrochloride 4 G (5.62%). Among bio-pesticides, Beauveria bassiana and Metarhizium anisopliae achieved damage levels of 6.14% and 6.29%, respectively. After the second spray, three days post-application, Fipronil 5 SC again exhibited the lowest damage at 4.86%. Seven days later, it remained the top performer with 3.31% dead hearts, followed by *Imidacloprid* 17.8 SC (3.84%). By day ten, *Fipronil* continued to show impressive results with just 2.03% dead hearts, reinforcing its superiority. In terms of yield, the highest production was recorded at 38.35 q/ha with *Fipronil* 5 SC, yielding a cost-benefit ratio of 1:6.66, while *Imidacloprid 17.8* SC yielded 37.26 q/ha with the best cost-benefit ratio of 1:7.83. Overall, all treated plots significantly outperformed the untreated control (26.60 q/ha), underscoring the effectiveness of insecticides like *Fipronil* and *Imidacloprid* in enhancing rice productivity.

ACKNOWLEDGEMENT

On behalf of all authors, I sincerely thank the Department of Entomology, S.V.P. University of Agriculture and Technology, Meerut and the Indian Council of Agricultural Research (I.C.A.R.), New Delhi, for providing the necessary facilities, guidance and support that enabled the timely completion of this research.

Declaration

The authors declare that this research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest. All findings and conclusions presented in this paper represent the original work of the authors, with no external influences affecting the study design, data interpretation, or reporting of the results.

Funding

All findings and interpretations are solely those of the authors.

Authorship

- Sushant Kumar: Writing-review and editing.
- Hem Singh: Supervision, Conceptualization and Methodology.
- D.V. Singh: Supervision and analysis.
- Shankar Dayal Bharti: Data curation.
- Chandan Kumar Panigrahi: Revision and Correction.
- Ankit Rai: Preparation of final draft.

Conflict of interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

REFERENCES

Anonymous (2010). Monitoring of pest species and their natural enemies. All India Coordinated Rice Improvement Programme. Annual Progress Report (Entomology). 2: 60-79.

Anonymous (2019). Ministry of Agriculture. (GOI), http://www.indiastat.com

Bharti, N., Singh, U.K., Kumar, V. and Kumar, A. (2018). Evaluation of insecticides and bio-pesticides against rice stem borer *Scirpophaga incertulas* (Walker) and leaf folder (*Cnaphalocrocis medinalis*) in *Kharif* rice under farmers field condition. International Journal of Current Microbiology and Applied Sciences. 7: 3436-3441.

Chatterjee, S. and Mondal, P. (2014). Management of rice yellow stem borer, *Scirpophaga incertulas* walker using some biorational insecticides. Journal of Bio Pest. 7: 143-147.

Kakde, A.M. and Patel, K.G. (2019). Yield performance of different insecticides against rice yellow stem borer, *Scirpophaga incertulas* WLK. Journal of Rice Research. 7(1): 203.

Katel, S., Lamshal, B.S., Yadav, S.P.S., Timsina, S., Mandal, H.R. and Kattel, S. (2023). Efficacy of different insecticides against the yellow stem borer (*Scirpophaga incertulus* Walker) (Lepidoptera: Crambidae) in spring rice cultivation. Cogent Food and Agriculture. https://doi.org/10.1080/23311932.2023.2218254.

Kumar, S. and Singh, H. (2020) Studies on the influence of insecticides and bio-pesticides for the management of brown plant hopper, *Nilaparvata lugens* (Stal) in the condition of western U.P. (India). International Journal of Tropical Insect Science. https://doi.org/10.1007/s42690-020-00342-1.

Kumar, S., Ajaharuddin, S.M., Tejaswini, R., Patel, A., Yadav, A., Rebasiddanavar, R.M. and Yadav, A. (2024). Impact of weather parameters on the population fluctuation of major sucking pest in summer mung bean [*Vigna radiata* (L.) Wilczek]. Legume Research. doi: 10.18805/LR-5317.

Kumar, S., Singh, H., Yadav, A., Kumar, A. and Shanker, R. (2019). Seasonal abundance of brown plant hopper, *Nilaparvata lugens* (Stal) in basmati rice and correlation of abiotic factors under Meerut region. Journal of Entomology and Zoology Studies. 7(6): 882-885.

Kumar, V. and Kumar, S. (2017). Evaluation of novel groups of insecticides against leaf folder, *Cnaphalcrocis medinalis* (Guenee) in rice crop. International Journal of Current Microbiology and Applied Sciences. 6(9): 442-448.

Lal, O.P. (1996). Recent advances in Entomology (Ed.). Lal, O.P. APC publication pvt. Ltd. N. Delhi. 392.

Lal, R. (2006). Effect of fipronil on the incidence of stem borer in basmati rice. Pesticides Research Journal. 18(2): 146-149.

Mishra, D.N., Kumar, K. and Singh, S.B. (2009). Economics and efficacy of some newer insecticides against linseed budfly *Dasyneura lini* Barnes in linseed under mid-western plain zone of UP. Environment and Ecology. 27(4B): 1907-1909.

Panda, B.M., Rath, L.K. and Dash, D. (2004). Effect of fipronil on yellow stem borer *Scirpophaga incertulas* walker and certain plant growth parameters in rice. Indian Journal of Entomology. 66(1): 17-23.

Pandey, S. and Choubey, M.N. (2012). Management of yellow stem borer, *Scirpophaga incertulas* in rice. Agricultural Science Digest. 32(1): 7-12.

Panse, V.G. and Sukhatme, P.V. (1978). Statistical methods for agricultural workers. ICAR Revised Edition. New Delhi, India. Page: 347.

Roshan, L. (2006). Bio-efficacy of different insecticides against stem borers in scented rice. Journal of Applied Zoological Researches. 17(1): 15-17.

Sangamithra, S.B., Vinoth kumar, T., Manoharan, N., Muthukrishnan and Rathish, S.T. (2018). Evaluation of bio-efficacy, phytotoxicity of Imidacloprid 17.1 per cent SL against plant and leaf hoppers and its safety to non-target invertebrates in rice. Journal of Entomology and Zoology Studies. 6(1): 230-234.

Seni, A. and Naik, B.S. (2017). Efficacy of some insecticides against major insect pests of rice, *Oryza sativa* L. Journal of Entomology and Zoology Studies. 5(4): 1381-1385.

Sheoran, O.P. (2004). "OPSTAT1", 10 state pack for analysis. Computer Section, CCS HAU, Hisar.

Singh, R., Shrivastava, D.K., Kumar, D. and Kumar, S. (2017). Efficacy of different novel insecticides and bio-pesticides against stem borer *Scirpophaga incertulus* (Walker).

Singh, D., Bhatnagar, P., Om, H. and Sheokand, R.S. (2010). Efficacy of insecticides against stem borer, *Scirpophaga incertulas* (Walker) and leaf folder, *Cnaphalocrocis medicinalis* (Guenne) in Basmati rice. Environment and Ecology. 28(2): 884-886.

Singh, S.P. (2000). Bio-intensive approach helpful. The Hindu Survey of Indian Agriculture. 159-163.

Sulagitti, A., Jagginavar, S.B. and Biradar, A.P. (2017). Evaluation of biopesticides against yellow stem borer (*Scirpophaga incertulas* Walker) in rice. Journal of Experimental Zoology India. 20(2): 877-881.

Suri, K.S. and Makkar, G.S. (2016). Efficacy assessment of fipronil 0.6% gr against rice stem borers and leaffolder. Journal of experimental Zoology India. 19(2): 857-861.