

Bio-efficacy of Pymetrozine 50 WG Against Brown Planthopper, *Nilaparvata lugens* Stal., Safety to Natural Enemies and Residues in Rice Under Field Conditions of Semi-arid Region of India

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Abstract

The brown plant hopper, *Nilaparvata lugens* Stal, is a significant insect pest that severely damage rice crops in India. Various management strategies have been implemented to control this pest, with insecticides serving as the primary defence mechanism. Therefore, there is a need to identify new molecules that have selective properties, innovative modes of action, low toxicity to non-target organisms, and environmental safety, all aimed at achieving sustainable pest management. In this context, the bio-efficacy of pymetrozine 50 WG against brown plant hopper, *Nilaparvata lugens* Stal. was assessed under field conditions at CCS Haryana Agricultural University, Regional Research Station, Karnal, over two *kharif* seasons. Results indicated that the foliar application of pymetrozine 50 WG at a rate of 150 g a.i. per hectare (5–10 hoppers per hill) was the most effective dose for reducing hopper populations. No phytotoxicity was observed in rice crops following the foliar spray of pymetrozine 50 WG. This chemical also showed relative safety towards natural enemies, including spiders, mirid bugs, and coccinellids. The highest grain yields recorded were 36.1 and 38.2 quintals per hectare with the application of pymetrozine 50 WG at 175 g a.i. per hectare during both seasons, which were comparable to the lower dose of 150 g a.i. per hectare (35.2 and 37.3 quintals per hectare). At harvest, the residues of pymetrozine 50 WG at the recommended dose (150 g a.i. per hectare) and double that rate (300 g a.i. per hectare) were found to be below detectable levels in the soil, rice straw, and grain.

Keywords: Pymetrozine 50 WG, brown planthopper, *Nilaparvata lugens*, phytotoxicity, natural enemies, bio-efficacy

1. Introduction

Rice (*Oryza sativa* L.) is a significant staple food crop in India, cultivated across an area of 46.28 million hectares, with an annual production of 129.47 million tons (USDA 2023). Commonly known as the “King of cereals,” it ranks second in terms of productivity, just behind corn. Asia is regarded as the world’s rice bowl, producing and

consuming over 90 percent of the global rice supply. In order to meet the growing demand of increasing population, we need to produce 1.0 million tons of more rice every year and concentrated efforts are needed by researchers and farmers alike without adversely affecting the resource base. Rice production however, is limited by



both biotic and abiotic stresses primarily due to economic losses caused by insect-pests and there is dire need to reduce these yield losses. The insect-pests being the major factor causing economic losses to the tune of 27.9 per cent (Mondal *et al.*, 2017) and alone cause losses amounting to Rs. 240,138 million (Dhaliwal *et al.*, 2007). Twenty of the approximately 100 insect species that are known to attack rice crops from nursery to maturity are often identified as significant pests with significant economic impact (Rahaman and Stout, 2019).

In addition to the closed canopy of rice plants, densely seeded crops, and excessive use of nitrogen fertilizers, brown plant hopper (BPH), *Nilaparvata lugens* Stal. (Delphacidae: Hemiptera), is a significant problem in irrigated wetland environments because it promotes the growth of insects (Satpathi *et al.*, 2012; Ali *et al.*, 2017). BPH has become a major pest partly due to the fact that high yielding varieties and hybrids provide a favorable microclimate for its survival and multiplication. Both immature stages and adults usually congregate near the base of rice plants and suck sap from the phloem and xylem. Their continuous feeding results in leaf yellowing, plant wilting and in severe cases, complete drying of the rice plants. The damage typically spreads in circular patches, a phenomenon known as 'hopper burn.' Without prompt management, such infestations can spread rapidly and devastate an entire crop within two to three weeks.

Several approaches have been attempted to manage BPH, but none have provided consistent and adequate control. In situations where the population exceeds the economic threshold level (ETL), farmers often depend primarily on insecticides as the first line of defense. However, indiscriminate and repeated use of conventional broad-spectrum insecticides not only diminishes natural enemy populations but also triggers secondary pest outbreaks and contaminates the environment. In fact, multiple cases of plant hopper resurgence in Southeast Asia have been documented (Heinrichs *et al.*, 1982), where complete crop losses were associated with the elimination of natural enemies due to excessive chemical applications. This growing concern has emphasized the need for safer alternatives, particularly new molecules that target specific pests and break down quickly in the environment. Pymetrozine 50 WG, a pyridine azomethine insecticide, represents such an option. It acts uniquely as a stylet inhibitor, preventing insects from inserting their

mouthparts into plant tissues. Despite its potential, limited information is available on residue dynamics, large-scale validation in farmers' fields, and assessment across multiple locations. Considering these factors, a study was carried out to evaluate the bio-efficacy of pymetrozine 50 WG (Syngenta India Pvt. Ltd.) against BPH in rice during the *kharif* seasons of 2015 and 2019.

2. Materials and Methods

2.1. Research trials

A field experiment was conducted at the research farm of CCS Haryana Agricultural University, Regional Research Station, Karnal to evaluate the bio-efficacy of pymetrozine 50 WG against brown plant hopper, *Nilaparvata lugens* in rice during *kharif*, 2015 and 2019. Pymetrozine 50 WG was tested at four doses *viz.*, 100, 125, 150 and 175 g a.i./ha and were compared with standard check, buprofezin 25 SC (Tribune 25 SC) @ 206.25 ml a.i./ha and untreated control in Randomized Block Design with four replications. The rice seedlings of variety, CSR30 were transplanted on 14th July, 2015 and 15th July, 2019 during *kharif*, 2015 and 2019, respectively at the research farm. Each treatment was established in plots measuring 7.0 × 5.0 m, with seedlings planted at a spacing of 20 cm × 15 cm. The crop was managed following the standard recommended practices of Chaudhary Charan Singh Haryana Agricultural University, Hisar (Anonymous, 2019), except for plant protection interventions. Insecticide applications against BPH were carried out according to the protocols outlined for the experiment (Table 1).

Observations on brown planthopper populations were recorded from 10 randomly selected hills per plot one day before spraying, and at 1, 3, 5, 10, and 14 days after each spray. Data are presented as the average number of BPH per hill. Observations on nymphs and adults were counted immediately after gently tapping the plants over a white tray half filled with water. Insecticides were applied using a knapsack sprayer, with two spray applications for each treatment. The first spray was conducted when BPH populations exceeded the economic threshold level (5-10 nymphs/adults per hill), and the second spray was applied 15-25 days later if populations again reached the threshold. A water volume of 500 L/ha was used for each application. Additionally, observations on population of natural enemies were monitored in each plot.



Table 1: Details of treatments for evaluation of bio-efficacy of pymetrozine 50 WG against brown plant hopper, *Nilaparvata lugens* in rice during *kharif*, 2015 and 2019

Treatments	Treatment details	Dose (g/ml a.i./ha)	Dose (formulation g or ml/ha)
T1	Pymetrozine 50 WG	100	200
T2	Pymetrozine 50 WG	125	250
T3	Pymetrozine 50 WG	150	300
T4	Pymetrozine 50 WG	175	350
T5	Buprofezin 25 % SC	206.25	825
T6	Untreated control	-	-
T7	Pymetrozine 50 WG	300	600

* T7 only for residue studies (2019)

Phytotoxic effects of pymetrozine 50 WG were also recorded in all the treatments along with the control from ten randomly selected plants at 1, 3, 5, 10 and 14 days after spray. Phytotoxicity symptoms *viz.*, leaf injury, vein clearing, leaf necrosis, leaf epinasty, yellowing, stunting and hyponasty on a scale of 0-10 as per Ambarish *et al.* (2017) after both sprays at dose of 100g, 125g, 150g and 175 g a.i./ha. Grain yield per plot was recorded and converted on hectare basis. Cost benefit ratio was also recorded.

Residue studies were carried out during *kharif*, 2019. Treatments included the application of standard recommended dose of pymetrozine 50 WG @ 150 g a.i./ha and 300g a.i./ha (double the recommended dose) and untreated control with three replications. Samples of soil, leaves/straw and rice grains were collected on the 3rd November, 2019 at time of crop harvesting. Samples were stored under appropriate conditions, and rice grains were dehulled prior to residue analysis. The residues of pymetrozine 50 WG at harvest were quantified using High-Performance Liquid Chromatography (HPLC) with a Waters e2695 system (e-alliance) at the Residue Analysis Laboratory, Department of Agronomy, CCS HAU, Hisar. All analyses were performed in triplicate to ensure accuracy and reproducibility of the results.

2.2. Farmers' field trials

Adaptive trials were conducted at farmers' fields during *Kharif* 2019 to evaluate pymetrozine 50 WG @ 150 g a.i. per ha compared with an untreated control. Seven multi-location trials were established, each with a plot size of 0.2 ha for treated and untreated plots. Five trials were conducted in Karnal district (Subri, Sarfabad Majra, Amargarh, Sandhir, and Kharkali villages), and one trial

each in Kurukshetra (Amin village) and Kaithal (Kaul village) districts. Farmers were randomly selected and at least one trial per district was initiated based on pest incidence when BPH populations exceeded the economic threshold level (5-10 nymphs/adults per hill).

The crop was managed according to the standard recommended practices of CCS Haryana Agricultural University, Hisar. Insecticide applications were carried out in treated plots, while untreated plots received no BPH control measures. Observations on BPH populations were recorded from 10 randomly selected hills per plot before spraying, and at 5, 10, and 15 days after spraying and data is presented as average number of hoppers per hill. Observations on nymphs and adults were immediately counted after gently tapping the plants over a white water tray. Insecticides were applied using a knapsack sprayer, with two sprays per treatment. The first spray was conducted when BPH populations reached the economic threshold level and the second spray was repeated if populations again exceeded the threshold. A water volume of 500 L/ha was maintained for each application and grain yield from each plot was recorded and converted to a per-hectare basis.

2.3. Statistical analysis

Data were analyzed using analysis of variance (ANOVA) following the procedure outlined by Gomez and Gomez (1984), with appropriate transformations applied prior to analysis. Treatment means were compared using Tukey's Honestly Significant Difference (HSD) test at the 5% probability level. All statistical computations were performed using SPSS version 23.0 (IBM Corp., 2015).



3. Results and Discussion

3.1. Bio-efficacy of pymetrozine 50 WG against brown planthopper, *Nilaparvata lugens*

Results of investigations during *kharif*, 2015 on bio-efficacy of pymetrozine 50 WG against brown planthopper, *N. lugens* after first spray are presented in Table 2. Results indicated that BPH population one day before spray was observed uniform throughout the experimental field and it did not vary significantly among the treatments. One day after spray (DAS), the lowest population of BPH (6.3 hoppers/hill) was observed in spray of pymetrozine 50 WG @ 175 g a.i./ha which was at par with pymetrozine 50 WG @ 150 g a.i./ha (6.8 hoppers/hill). However, minimum BPH population (1.8 hoppers/hill) was observed at 5 DAS in spray of pymetrozine 50 WG @ 175 g a.i./ha which was at par with pymetrozine 50 WG @ 150 g a.i./ha (2.0 hoppers/hill). These two treatments i.e. pymetrozine 50 WG @ 175 and 150 g a.i./ha were also found significantly superior over the other treatments including untreated control. Standard check, buprofezin 25 SC (Tribune 25% SC) @ 825 ml/ha was also found superior over untreated control. However, it was inferior to pymetrozine 50 WG @ 150 and 175 g a.i./ha. All insecticidal treatments were found superior over the untreated control in reducing BPH populations after the first spray and a similar trend was maintained at 3, 5, 10, and 14 DAS. Although a slight increase in hopper numbers was noted at 10 DAS, the mean population across all observations (1, 3, 5, 10, and 14 DAS) remained lowest in plots treated with pymetrozine 50 WG @ 175 g a.i./ha (3.6 hoppers/hill), which was statistically at par with pymetrozine 50 WG @ 150 g a.i./ha (3.9 hoppers/hill). The maximum reduction in hopper population (82.9%) was achieved with pymetrozine 50 WG @ 175 g a.i./ha, followed closely by pymetrozine 50 WG @ 150 g a.i./ha (81.5%). A similar reduction pattern was observed after the second spray during *Kharif* 2015 (Table 3). One day after the second spray, the lowest BPH population (5.4 hoppers/hill) was recorded in plots treated with pymetrozine 50 WG @ 175 g a.i./ha, which was at par with pymetrozine 50 WG @ 150 g a.i./ha (5.8 hoppers/hill). At 5 DAS, the minimum population (2.8 hoppers/hill) was again observed with pymetrozine 50 WG @ 175 g a.i./ha, statistically comparable to pymetrozine 50 WG @ 150 g a.i./ha (3.2 hoppers/hill). All insecticidal treatments were superior to the untreated control in lowering BPH

populations after the second spray as well, with the maximum reduction (82.4%) obtained at pymetrozine 50 WG @ 175 g a.i./ha, followed by pymetrozine 50 WG @ 150 g a.i./ha (80.8%).

The results of investigations conducted during *Kharif* 2019 on the bio-efficacy of pymetrozine 50 WG against brown planthopper, *N. lugens*, after the first spray are presented in Table 4. The BPH population was uniform across all treatments, including the control, one day prior to spraying. One day after spray, the lowest population (7.0 hoppers/hill) was recorded with pymetrozine 50 WG @ 175 g a.i./ha, which was statistically at par with pymetrozine 50 WG @ 150 g a.i./ha (8.6 hoppers/hill). At 5 DAS, the minimum BPH population (3.3 hoppers/hill) was observed in the pymetrozine 50 WG @ 175 g a.i./ha treatment, which was at par with pymetrozine 50 WG @ 150 g a.i./ha (4.6 hoppers/hill). The standard check, buprofezin 25 SC (Tribune 25 SC) @ 825 ml/ha, was effective compared to the untreated control but remained inferior to pymetrozine 50 WG at 150 and 175 g a.i./ha. All insecticidal treatments significantly reduced BPH populations compared to the untreated control after the first spray, with a similar trend observed at 3, 5, 10, and 14 DAS. However, population of hopper increased at 10 days after spray. Data on mean population of different observations (1, 3, 5, 10 and 14 DAS) indicated the lowest mean population (5.4 hoppers/hill) in the plots sprayed with pymetrozine 50 WG @ 175 g a.i./ha which was also found at par with pymetrozine 50 WG @ 150 g a.i./ha (6.4 hoppers/hill). Maximum reduction in hopper population (80.1%) was observed in pymetrozine 50 WG @ 175g a.i./ha and it was followed by pymetrozine 50 WG @ 150 g a.i./ha (76.9%). Similar trend in reduction of hopper and number of hoppers/hill was observed after second spray during *kharif*, 2019 (Table 5). One day after spray, the lowest population of BPH (5.1 hoppers/hill) was observed in spray of pymetrozine 50 WG @ 175 g a.i./ha which was at par with pymetrozine 50 WG @ 150 g a.i./ha (5.5 hoppers/hill). Minimum BPH population (3.4 hoppers/hill) was observed at 5 DAS in spray of pymetrozine 50 WG @ 175 g a.i./ha which was at par with pymetrozine 50 WG @ 150 g a.i./ha (4.1 hoppers/hill). All insecticidal treatments were found superior over untreated control in lowering population of BPH after second spray. Similar trend was also observed at 3, 5, 10 and 14 days after the second spray. Maximum reduction in hopper population



Table 2: Bio-efficacy of pymetrozine 50 WG against brown plant hopper, *Nilaparvata lugens* in rice during *kharif*, 2015 (first spray)

Treatments	Treatment details	Dose (g/ml ai per ha)	Dose product (g/ml per ha)	Population of brown plant hopper/hill					Per cent reduction in hopper population over control
				1 day before spray	1 DAS	3 DAS	5 DAS	10 DAS	
T1	Pymetrozine 50 WG	100	200	19.4 (4.52)*	13.7 (3.83)	9.4 (3.22)	7.1 (2.85)	7.4 (2.90)	54.5
T2	Pymetrozine 50 WG	125	250	19.8 (4.56)	11.1 (3.48)	8.9 (3.15)	5.1 2.47)	5.0 (2.47)	63.0
T3	Pymetrozine 50 WG	150	300	21.1 (4.70)	6.8 (2.79)	4.9 (2.43)	2.0 (1.73)	2.1 (1.73)	81.5
T4	Pymetrozine 50 WG	175	350	20.6 (4.65)	6.3 (2.70)	4.2 (2.28)	1.8 (1.67)	2.0 1.67)	82.9
T5	Buprofezin 25 % SC	206.25	825	21.5 (4.74)	10.4 (3.38)	9.0 (3.16)	4.2 (2.29)	4.9 (2.34)	64.0
T6	Untreated control	-	-	21.7 (4.76)	21.0 (4.69)	20.1 (4.59)	22.2 (4.82)	21.8 (4.80)	-
	C.D.(P=0.05)			(NS)	(0.28)	(0.34)	(0.38)	(0.31)	-
	SE(m) ±			(0.03)	(0.04)	(0.04)	(0.06)	(0.03)	-
	CV (%)			(9.2)	(10.2)	(8.5)	(7.4)	(12.1)	-

*Figures in parentheses are square root transformation

Table 3: Bio-efficacy of pymetrozine 50 WG against brown plant hopper, *Nilaparvata lugens* in rice during *kharif*, 2015 (second spray)

Treatments	Treatment details	Dose (g/ml ai per ha)	Dose product (g/ml per ha)	1 day before spray	Population of brown plant hopper/hill					Per cent reduction in hopper population over control
					1 DAS	3 DAS	5 DAS	10 DAS	14 DAS	
T1	Pymetrozine 50 WG	100	200	19.9 (4.57)	11.5 (3.54)	8.8 (3.13)	7.6 (2.93)	7.9 (2.98)	10.2 (3.35)	57.0
T2	Pymetrozine 50 WG	125	250	16.4 (4.17)	10.2 (3.35)	8.3 (3.05)	6.7 (2.77)	7.1 (2.85)	10.8 (3.43)	59.8
T3	Pymetrozine 50 WG	150	300	14.7 (3.96)	5.8 (2.61)	4.1 (2.26)	3.2 (2.05)	3.4 (2.10)	4.0 (2.24)	80.8
T4	Pymetrozine 50 WG	175	350	14.1 (3.89)	5.4 (2.53)	3.6 (2.14)	2.8 (1.95)	3.0 (2.00)	3.5 (2.12)	82.4
T5	Buprofezin 25 % SC	206.25	825	17.4 (4.29)	11.6 (3.55)	7.7 (2.95)	5.8 (2.61)	6.3 (2.70)	10.4 (3.38)	60.7
T6	Untreated control	-	-	20.8 (4.67)	21.3 (4.72)	21.5 (4.74)	21.4 (4.74)	22.6 (4.86)	20.3 (4.61)	-
	C.D.(P=0.05)			(0.22)	(0.36)	(0.43)	(0.40)	(0.37)	(0.30)	-
	SE(m) ±			(0.03)	(0.03)	(0.04)	(0.04)	(0.03)	(0.04)	-
	CV (%)			(8.2)	(7.2)	(11.2)	(10.6)	(9.7)	(13.2)	-

*Figures in parentheses are square root transformation



**Table 4:** Bio-efficacy of pymetrozine 50 WG against brown plant hopper, *Nilaparvata lugens* in rice during *kharif*, 2019 (first spray)

Treatments	Treatment details	Dose (g/ ml ai per ha)	Dose product (g/ ml per ha)	Population of brown plant hopper/hill						Per cent reduction over control	
				1 day before spray	1 DAS	3 DAS	5 DAS	10 DAS	14 DAS		Mean
T1	Pymetrozine 50WG	100	200	25.3 (5.13)	15.3 (4.04)	12.8 (3.71)	8.3 (3.05)	9.1 (3.18)	10.0 (3.32)	11.1 (3.46)	59.9
T2	Pymetrozine 50 WG	125	250	25.5 (5.15)	14.3 (3.91)	11.5 (3.54)	6.5 (2.75)	8.1 (3.02)	8.7 (3.11)	9.8 (3.27)	64.6
T3	Pymetrozine 50 WG	150	300	25.3 (5.13)	8.6 (3.10)	6.6 (2.76)	4.6 (2.37)	5.9 (2.63)	6.2 (2.68)	6.4 (2.71)	76.9
T4	Pymetrozine 50 WG	175	350	26.8 (5.27)	7.0 (2.83)	6.0 (2.65)	3.3 (2.07)	4.6 (2.37)	5.9 (2.63)	5.4 (2.51)	80.1
T5	Buprofezin 25 % SC	206.25	825	26.8 (5.27)	12.8 (3.71)	10.4 (3.38)	7.4 (2.90)	7.4 (2.90)	7.6 (2.93)	9.1 (3.16)	67.1
T6	Untreated control	-	-	26.5 (5.24)	28.3 (5.41)	26.8 (5.27)	25.5 (5.15)	28.5 (5.43)	29.3 (5.50)	27.7 (5.35)	
	C.D. (P=0.05)			(NS)	(0.43)	(0.42)	(0.35)	(0.32)	(0.38)	(0.38)	
	SE(m) ±			(0.04)	(0.03)	(0.05)	(0.04)	(0.05)	(0.03)	(0.05)	
	CV (%)			(10.2)	(9.4)	(9.3)	(13.2)	(8.1)	(7.4)	(9.5)	

*Figures in parentheses are square root transformation

Table 5: Bio-efficacy of pymetrozine 50 WG against brown plant hopper, *Nilaparvata lugens* in rice during *kharif*, 2019 (second spray)

Treatments	Treatment details	Dose (g/ml ai per ha)	Dose product (g/ml per ha)	1 day before spray	Population of brown plant hopper/hill						Per cent reduction over control
					1 DAS	3 DAS	5 DAS	10 DAS	14 DAS	Mean	
T1	Pymetrozine 50 WG	100	200	17.5 (4.30)	12.2 (3.63)	10.6 (3.41)	8.1 (3.02)	8.5 (3.08)	10.1 (3.33)	9.9 (3.30)	61.2
T2	Pymetrozine 50 WG	125	250	17.0 (4.24)	10.5 (3.39)	9.2 (3.19)	7.5 (2.91)	7.6 (2.93)	8.8 (3.13)	8.7 (3.11)	66.2
T3	Pymetrozine 50 WG	150	300	15.5 (4.06)	5.5 (2.55)	4.4 (2.32)	4.1 (2.26)	5.5 (2.55)	6.3 (2.70)	5.2 (2.48)	79.8
T4	Pymetrozine 50 WG	175	350	12.8 (3.71)	5.1 (2.47)	3.8 (2.19)	3.4 (2.10)	4.0 (2.24)	5.1 (2.47)	4.3 (2.29)	83.3
T5	Buprofezin 25 % SC	206.25	825	19.3 (4.51)	10.9 (3.45)	7.4 (2.90)	7.7 (2.95)	8.1 (3.02)	9.9 (3.30)	8.8 (3.12)	65.8
T6	Untreated control	-	-	29.0 (5.48)	27.5 (5.34)	28.2 (5.40)	26.8 (5.27)	21.8 (4.77)	24.8 (5.08)	25.8 (5.17)	-
	C.D.(P=0.05)			(0.35)	(0.41)	(0.44)	(0.39)	(0.37)	(0.40)	(0.40)	-
	SE(m) ±			(0.04)	(0.03)	(0.05)	(0.04)	(0.03)	(0.04)	(0.03)	
	CV (%)			(15.2)	(8.2)	(6.4)	(10.0)	(7.2)	(7.1)	(7.8)	-

*Figures in parentheses are square root transformation

(83.3%) was observed in pymetrozine 50 WG @ 175g a.i./ha and it was followed by pymetrozine 50 WG @ 150 g a.i./ha (79.8%).

The present findings are in agreement with those of Kirankumar (2016), who reported that pymetrozine 50 WG @ 350 g a.i./ha was significantly superior against brown planthopper, *Nilaparvata lugens*, in rice during the *Kharif* season and was statistically at par with 400 g a.i./ha. Similar results were documented by Deekshitha and Ramarao (2018), who observed that pymetrozine 50 WG was the most effective insecticide against BPH, achieving a 62.98% reduction in hopper population over control support findings of present investigations. The investigations of Gui *et al.* (2009) and Shanker *et al.* (2019), who also reported the efficacy of pymetrozine 50 WG in suppressing BPH populations, further support the present study. More recently, Harika and Deole (2023) confirmed that pymetrozine 50 WG @ 150 g a.i./ha was the most effective treatment, recording the highest reduction in BPH population with 76.88% and 79.86% decline after the first and second sprays, respectively. Their findings of the lowest plant hopper counts (2.21 BPH/hill after the first spray and 2.28 BPH/hill after the second spray) are in close conformity with the present results.

3.2. Effect of pymetrozine 50 WG on natural enemies

The effect of pymetrozine 50 WG on natural enemies is presented in Tables 6 and 7. The results indicated that the population of predators/natural enemies (spiders, mirid bugs and coccinellid beetle) was statistically similar in all treatments including untreated control during both years of study (*Kharif* 2015 and 2019). Pymetrozine 50 WG at all the tested doses recorded statistically similar population of natural enemies with other treatments including untreated control in both the sprays. Therefore, all doses of tested chemical, pymetrozine 50 WG did not adversely affect the population of natural enemies in rice ecosystem.

Findings of Kirankumar (2016) who reported that pymetrozine 50WG @ recommended dose of 350g a.i./ha did not affect natural enemy's population support present investigations. He reported that no significant differences among the insecticidal treatments and untreated control at 1 day before spray and at 3 and 7 days after spray during both the years of the same seasons. The findings of Deekshitha and Ramarao (2018), who reported that pymetrozine 50 WG had no adverse effect on the natural

enemies also support present reports. Investigations of Harika and Deole (2023) who reported that spray of pymetrozine 50 WG recorded higher mean population of spiders (2.44/hill) and coccinellids (1.08/hill) in comparison with untreated plot also support present findings.

3.3. Effect of pymetrozine 50 WG on phyto-toxicity

Results showed that pymetrozine 50 WG was safe at all tested doses, with no phytotoxicity symptoms observed on the rice crop. Symptoms such as leaf injury, vein clearing, leaf necrosis, epinasty, hyponasty, yellowing, or stunting were absent across all treatments after both sprays during *Kharif* 2015 and 2019. The phytotoxicity score, measured on a 0-10 scale, remained zero for all insecticides, indicating 100 per cent safety to the crop. These findings are supported by Kirankumar (2016), who also reported that pymetrozine 50 WG at the recommended dose of 350 g a.i./ha was highly effective in reducing BPH populations without inducing any phytotoxic effects.

3.4. Effect of pymetrozine 50 WG on yield and cost benefit ratio

During *Kharif* 2015, the highest grain yield (36.1 q/ha) was recorded with pymetrozine 50 WG @ 175 g a.i./ha, which was statistically at par with pymetrozine 50 WG @ 150 g a.i./ha (35.2 q/ha). All insecticidal treatments resulted in significantly higher yields compared to the untreated control (Table 8). A similar trend was observed in the second year, where maximum yield (38.2 q/ha) was obtained with pymetrozine 50 WG @ 175 g a.i./ha, followed closely by 150 g a.i./ha (37.3 q/ha), both significantly superior to the control. In terms of economics, the highest cost-benefit ratio (3.21) was noted in pymetrozine 50 WG @ 175 g a.i./ha during *Kharif* 2015, which was at par with 150 g a.i./ha (3.17). The mean cost-benefit ratio across years was also highest in pymetrozine 50 WG @ 175 g a.i./ha (3.28), followed closely by pymetrozine 50 WG @ 150 g a.i./ha (3.24). These findings are in agreement with Kirankumar (2016), who reported that pymetrozine 50 WG @ 350 g a.i./ha was effective in reducing brown plant hopper infestation and improving yield support present results. Jaglan *et al.* (2022) provide partial support to the present findings, reporting maximum cost-benefit ratios of 2.80 and 2.54 during the 2018 and 2019 crop seasons, respectively, in insecticide-treated plots. In addition, they recorded maximum incremental





Table 6: Effect of pymetrozine 50 WG on population of natural enemies in rice during *kharif*, 2015

Treatments	Treatment details	Dose (g/ml ai per ha)	Dose (g/ml product (g/ ml per ha)	*Mean number of natural enemies/10 hills (after first spray)				*Mean number of natural enemies/10 hills (after second spray)			
				Spiders	Mirid bugs	Coccinellids	Spiders	Mirid bugs	Spiders	Mirid bugs	Coccinellids
T1	Pymetrozine 50 WG	100	200	2.74	0.87	0.64	2.24	0.65	2.24	0.65	0.46
T2	Pymetrozine 50 WG	125	250	2.65	0.84	0.64	2.19	0.61	2.19	0.61	0.45
T3	Pymetrozine 50 WG	150	300	2.67	0.78	0.62	2.17	0.60	2.17	0.60	0.44
T4	Pymetrozine 50 WG	175	350	2.61	0.74	0.61	2.11	0.59	2.11	0.59	0.40
T5	Buprofezin 25 % SC	206.25	825	2.64	0.76	0.67	2.23	0.61	2.23	0.61	0.42
T6	Untreated control	-	-	2.75	0.89	0.66	2.28	0.64	2.28	0.64	0.48
	C.D.(P=0.05)			NS	NS	NS	NS	NS	NS	NS	NS
	CV (%)			6.7	8.2	9.8	7.5	6.9	7.5	6.9	5.6

*Average of five observations

Table 7: Effect of pymetrozine 50 WG on population of natural enemies in rice during *kharif*, 2019

Treatments	Treatment details	Dose (g/ml ai per ha)	Dose (g/ml product (g/ ml per ha)	*Mean number of natural enemies/10 hills (after first spray)				*Mean number of natural enemies/10 hills (after second spray)			
				Spiders	Mirid bugs	Coccinellids	Spiders	Mirid bugs	Spiders	Mirid bugs	Coccinellids
T1	Pymetrozine 50 WG	100	200	2.00	1.13	0.83	1.12	0.85	1.12	0.85	0.75
T2	Pymetrozine 50 WG	125	250	1.88	1.06	0.95	1.38	0.76	1.38	0.76	0.73
T3	Pymetrozine 50 WG	150	300	2.13	0.93	0.88	1.37	0.75	1.37	0.75	0.70
T4	Pymetrozine 50 WG	175	350	1.75	0.86	0.73	1.31	0.73	1.31	0.73	0.63
T5	Buprofezin 25 % SC	206.25	825	2.13	1.06	0.93	1.35	0.75	1.35	0.75	0.68
T6	Untreated control	-	-	1.98	1.17	0.98	1.31	0.81	1.31	0.81	0.78
	C.D.(P=0.05)			NS	NS	NS	NS	NS	NS	NS	NS
	CV (%)			20.0	19.3	17.1	19.0	17.7	19.0	17.7	12.8

*Average of five observations

Table 8: Efficacy of pymetrozine 50 WG on yield and cost: benefit ratio of rice during *kharif*, 2015 and 2019

Treatments	Treatment details	Dose (g/ml ai per ha)	Dose product (g/ml per ha)	Yield (q/ha)		Cost : benefit ratio		
				2015	2019	Mean	2015	2019
T1	Pymetrozine 50 WG	100	200	28.1	32.4	30.3	2.96	3.06
T2	Pymetrozine 50 WG	125	250	30.3	33.8	32.1	2.98	3.09
T3	Pymetrozine 50 WG	150	300	35.2	37.3	36.3	3.17	3.31
T4	Pymetrozine 50 WG	175	350	36.1	38.2	37.2	3.21	3.34
T5	Buprofezine 25 % SC	206.25	825	31.2	33.5	32.4	3.01	3.07
T6	Untreated control	-	-	23.4	30.5	27.0	2.46	2.97
	C.D.(P=0.05)			3.6	2.8	3.2	0.15	0.19
	SE(m) ±			0.05	0.04	0.04	0.04	0.03
	CV (%)			10.9	8.4	9.7	5.4	6.2
								5.8

cost-benefit ratios of 10.48 and 9.69 in the same seasons, further corroborating the present results.

3.5. Residue studies

Analysis of samples collected at harvest revealed that residues of pymetrozine 50 WG were below the detectable limit (0.1 µg/g) in paddy grains, straw, and soil at both 150 g a.i./ha and 300 g a.i./ha, as well as in the untreated control, indicating the safety of the compound even at double the recommended dose. The maximum residue limit (MRL) for rice, as per the European Food Safety Authority (EFSA, 2012), is 0.02 µg/g. Residue analysis was performed with a limit of detection (LOD) of 0.005 µg/g and a limit of quantification (LOQ) of 0.01 µg/g, confirming residues were well below permissible levels. These results are consistent with previous findings. Li *et al.* (2010) reported that pymetrozine residues in brown rice reached a maximum of 0.01 mg/kg, below the EU MRL of 0.02 mg/kg, indicating safety for human and animal consumption, and observed that degradation occurred fastest in water, followed by rice straw. The present results are also partially supported by Kobashi *et al.* (2017), who found that residual concentrations of imidacloprid in water and rice fields were 5- to 10-fold higher than those of dinotefuran. Additionally, Rahman *et al.* (2013) reported that dinotefuran residues remained below the maximum residue limit in melon samples sprayed three times at seven-day intervals up to seven days before harvest, further supporting the safety of neonicotinoid insecticides under recommended usage.

3.6. Farmers, field trials

Data on BPH incidence and yield recorded from multi location trials during *kharif*, 2019 are presented in Table 9-10. The spray of pymetrozine 50 WG@ 150 g a.i./ha in 500 liters water resulted in reduction in BPH incidence and increase of yield over the untreated control. After first spray, mean population of BPH at 5 DAS was recorded 3.2 as against 30.6 hoppers/hill in untreated control. Mean population (5, 10 and 15 DAS) was recorded to be 5.4 hoppers as against 35.5 hoppers/hill in untreated control. After second spray, mean population of BPH at 5 DAS was recorded 2.9 as against 41.9 hoppers/hill in untreated control. Mean population (5, 10 and 15 DAS) was recorded to be 3.9 hoppers as against 37.5 hoppers/hill in untreated control. Average grain yield was 39.4 q/ha in pymetrozine 50 WG @ 150 g a.i. /ha as compared to 34.4 q/ha in the





Table 9: Efficacy of pymetrozine 50 WG on incidence of brown plant hopper, *Nilaparvata lugens* in rice at farmers' field trials during *khari*, 2019

Location	Village	District	Variety	First spray										
				Population of brown plant hopper/hill										
				Before spray		5 DAS		10 DAS		15 DAS		Mean populat- ion (Treated)	Mean populat- ion (Untreated control)	Decrease in hopper over Untreated control (%)
				Treated	Untreated control	Treated	Untreated control	Treated	Untreated control	Treated	Untreated control			
I	Subri	Karnal	PB 1121	16.5	15.8	2.6	22.5	4.5	28.4	9.4	32.3	5.5	27.7	80.1
II	Sarfabad Majra	Karnal	PB 1121	23.4	24.5	3.7	27.6	4.9	31.4	9.2	35.4	5.9	31.5	81.3
III	Amargarh	Karnal	PB 1121	18.2	19.7	3.0	24.2	4.6	32.8	7.5	36.2	5.0	31.1	83.9
IV	Sandir	Karnal	CSR 30	32.5	33.6	4.2	36.7	5.0	42.6	8.4	44.5	5.9	41.3	85.7
V	Kharkali	Karnal	CSR 30	28.4	27.8	3.5	33.8	4.8	39.8	7.1	41.5	5.1	38.4	86.7
VI	Amin	Kurukshetra	CSR 30	36.8	35.9	2.8	40.3	3.4	43.4	9.5	48.7	5.2	44.1	88.2
VII	Kaul	Kaithal	CSR 30	19.7	20.2	2.4	28.9	3.6	35.2	8.7	40.1	4.9	34.7	85.9
	Average			25.1	25.3	3.2	30.6	4.4	36.2	8.5	39.8	5.4	35.5	84.5
Second Spray														
I	Subri	Karnal	PB 1121	9.9	33.4	2.7	33.6	4.2	32.4	4.8	28.2	3.9	31.4	87.6
II	Sarfabad Majra	Karnal	PB 1121	9.6	36.2	2.5	37.2	4.1	33.9	5.6	27.4	4.1	32.9	87.5
III	Amargarh	Karnal	PB 1121	8.4	35.4	1.9	36.9	3.5	34.2	4.6	29.5	3.3	33.5	90.4
IV	Sandir	Karnal	CSR 30	10.1	46.1	2.7	47.5	3.0	42.1	3.8	32.8	3.2	40.8	92.1
V	Kharkali	Karnal	CSR 30	9.5	43.4	3.2	44.2	4.1	39.7	4.5	34.6	3.9	39.5	90.1
VI	Amin	Kurukshetra	CSR 30	10.6	49.4	4.1	50.2	4.7	44.3	5.2	36.7	4.7	43.7	89.2
VII	Kaul	Kaithal	CSR 30	9.8	42.4	3.5	44.1	4.4	41.4	4.9	37.9	4.3	41.1	89.5
	Average			9.7	40.9	2.9	41.9	4.0	38.3	4.8	32.4	3.9	37.5	89.6

Table 10: Efficacy of pymetrozine 50 WG on yield and Cost: benefit ratio of rice at farmers field trials during *kharif*, 2019

Location	Village	District	Variety	Yield (q/ha)		Increase in yield over control (%)	Cost : benefit ratio	
				Treated	Control		Treated	Control
I	Subri	Karnal	PB 1121	42.6	37.4	12.2	2.94	2.56
II	Sarfabad Majra	Karnal	PB 1121	40.5	36.1	10.9	2.85	2.50
III	Amargarh	Karnal	PB 1121	42.4	36.9	13.0	2.91	2.52
IV	Sandir	Karnal	CSR 30	39.5	34.2	13.4	3.34	2.78
V	Kharkali	Karnal	CSR 30	36.7	32.3	12.0	3.22	2.61
VI	Amin	Kurukshetra	CSR 30	38.3	33.6	12.3	3.28	2.68
VII	Kaul	Kaithal	CSR 30	35.8	30.7	14.2	3.18	2.59
	Average			39.4	34.4	12.6	3.10	2.61

untreated control (Table 10). The average increase in grain yield over the untreated control was 12.6 per cent, with a mean cost-benefit ratio of 3.10 in treated plots compared to 2.61 in the untreated control (Table 10). No phytotoxic effects, such as necrosis, leaf tip injury, leaf surface damage, wilting, epinasty, or hyponasty, were observed in the multi-location trials at the recommended dose of pymetrozine 50 WG @ 150 g a.i./ha. Therefore, it is quite conspicuous from data from different locations under adaptive trials during the *kharif*, 2019 that pymetrozine 50 WG @ 150 g a.i./ha in 500 liters water resulted in significant reduction in BPH incidence and were superior over the untreated control and increased the grain yield appreciably. These findings are supported by Harika and Deole (2023), who reported that pymetrozine 50 WG @ 150 g a.i./ha achieved the highest overall reduction in BPH population, with 76.88% and 79.86% decline after the first and second sprays, respectively.

Conclusion

The results of present investigations on evaluation of bio-efficacy of pymetrozine 50 WG in rice during *kharif*, 2015 and 2019 indicate that spray application of pymetrozine 50 WG @ 150 g a.i./ha in 500 liters water effectively controlled brown plant hopper, *Nilaparvata lugens* which reduced insect infestation as compared to other treatments and untreated control with no phyto-toxicity on the crop and consequently resulted in increased grain yield. Spray of pymetrozine 50 WG @ 150 g a.i./ha is safe to natural enemies of insect- pests of rice as well as to crop with no detectable harmful residues at time of harvest. Therefore, spray application of pymetrozine 50 WG @ 150 g a.i./ha in 500 liters water was found best insecticidal treatment in reduction of BPH population and increase in grain yield and is recommended for adoption by farmers.

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Conflict of Interest

Authors declare that they do not have any conflict of interest.



Ethical Compliance Statement

NA

Authors' Contribution

Designing of experiment, data collection, analysis and preparation of manuscript by authors (MSJ, OPC, C and SSY), analysis and preparation of manuscript by author (VKK).

Generative AI or AI/Assisted Technologies use in Manuscript Preparation

No

References

1. Ali MP, MN Bari, N Ahmed, MMM Kabir, S Afrin, MAU Zaman, SS Haque and JL Willers. 2017. Rice production without insecticide in smallholder farmer's field. *Front Environment Science* 5:16. <https://doi.org/10.3389/fenvs.2017.00016>
2. Ambarish S, AP Biradar and SB Jagginavar. 2017. Phytotoxicity and their bio-efficacy of pesticides against key insect pests of Rabi sorghum [*Sorghum bicolor* (L.) Moench]. *Journal of Entomology and Zoology Studies* 5(2):716–720.
3. Anonymous. 2019. Package of practices for Kharif crops. Published by Publication cell, Directorate of Extension Education, Chaudhary Charan Singh Haryana Agricultural University, Hisar, pp 1-37.
4. Deekshita K and CV Ramarao. 2018. Pymetrozine: A Pyridine Azomethine insecticide for management of rice brown plant hopper in India. *Chemical Science Review and Letters* 7(25): 335-339.
5. Dhaliwal GS, AK Dhawanand and R Singh. 2007. Biodiversity and ecological agriculture: Issues and Perspectives. *Indian Journal of Ecology* 34 (2): 100-109.
6. Gomez KA and AA Gomez. 1984. *Statistical procedures for Agricultural Research*. Wiley, New York.
7. Gui Z, AG Yang, WU Zhong-Yan and WU Aio-Guo. 2009. Field efficacy trials of 25% pymetrozine SC against brown rice planthopper in field. *World Pesticides* 5: 37-38.
8. Harika R and Deole S. 2023. Evaluation of selected insecticides against brown planthopper and their impact on natural enemies. *The Pharma Innovation Journal* 12(7): 2570-2573.
9. Heinrichs EA, GB Aquino, S Chelliah, SL Valencia and WH Reissig. 1982. Resurgence of *Nilaparvata lugens* (Stål) populations as influenced by method and timing of insecticide applications in lowland rice. *Environmental Entomology* 11(1): 78-84. <https://doi.org/10.1093/ee/11.1.78>.
10. IBM Corp. 2015. *SPSS: IBM SPSS Statistics for Windows*, Version 23.0. Armonk: IBM Corp.
11. Jaglan MS, OP Chaudhary, Chitraklekha, S Singh, SS Yadav, A Duhan and J Yadav. 2022. Bioefficacy and post-harvest residue estimation of natural enemy friendly dinotefuran 20 SG against brown planthopper (*Nilaparvata lugens* Stål) in rice (*Oryza sativa* L.). *International Journal of Tropical Insect Science* 42:2547–2558.
12. Kobashi K, T Harada, Y Adachi and M Mori. 2017. Comparative ecotoxicity of imidacloprid and dinotefuran to aquatic insects in rice mesocosms. *Ecotoxicology Environment Safety* 138:122–129.
13. Kirankumar R. 2016. Efficacy of pymetrozine 50 WG against brown planthopper, *Nilaparvata lugens* (Stal.) on paddy *Oryza sativa* L. *International Journal of Plant Protection* 9(1): 68-78.
14. Li C, T Yang, W Huangfu and Y Wu. 2010. Residues and dynamics of pymetrozine in rice field ecosystem. *Chemosphere* 82(6): 901-4. DOI:10.1016/j.chemosphere.2010.10.053
15. Mondal D, A Ghosh, D Roy, A.Kumar, D Shamurailatpam, S Bera, R Ghosh, P Bandopadhyay and A Majumder. 2017. Yield loss assessment of rice (*Oryza sativa* L.) due to different biotic stresses under system of rice intensification (SRI). *Journal of Entomology and Zoological Studies* 5(4): 1974–1980.
16. Rahaman MM and MJ Stout. 2019. Comparative efficacies of next-generation insecticides against yellow stem borer and their effects on natural enemies in rice ecosystem. *Rice Science* 26(3): 157–166. <https://doi.org/10.1016/j.rsci.2019.04.002>.
17. Rahman MM, JH Park, AA El-Aty, JH Choi, A Yang, KH Park and JH Shim. 2013. Feasibility and application of an HPLC/UV-D to determine dinotefuran and its shorter wavelength metabolites residues in melon with tandem mass confirmation.



- Food Chemistry* **136**(2):1038–1046. <https://doi.org/10.1016/j.foodchem.2012.08.064>
18. Satpathi, CR, K Chakraborty and P Acharjee. 2012. Impact of seedling spacing and fertilizer on brown plant hopper, *Nilaparvata lugens* Stal incidence in rice field. *Journal of Biology Chemistry Research* **29** (1): 26–36.
19. Shankar M, G Shivaprasad, K Sumalini, RV Balazzii and K Cheeranjeevi. 2019. Bio-efficacy and phytotoxicity of novel insecticides against brown plant hopper, *Nilaparvata lugens* Stal. (Hemiptera: delphacidae) on rice. *Journal of Entomology and Zoology Studies* **7**(5): 860-865.
20. USDA. 2023. *World Agricultural Production Circular Series* WAP 6-23 June 2023. Accessed at <https://apps.fas.usda.gov/PSDOnline/Circulars/2023/06/production.pdf>

