Research Article

Pymetrozine: A Pyridine Azomethine insecticide for management of rice brown planthopper in India

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Abstract
Field trail was conducted at Agricultural College Farm, Bapatla during, *kharif* 2015 to evaluate the bio- efficacy of eight new insecticide molecules against Brown planthopper, and their impact on natural enemies. The pooled data on planthoppers after two sprays revealed that pymetrozine 50 WG was the best insecticide in controlling planthopper population and recorded with 62.98 per cent reduction over control followed by dinotefuran 20 SG and sulfoxaflor 25 SC. The traditional neonicotinoid imidacloprid, acetamiprid and thiomethoxam was proved ineffective in reducing the planthopper population. Pymetrozine ranked first in safety to green miridbugs (1:0.76) and spiders (1:0.07) as per the pest defender ratios and significantly superior to all other treatments. The highest yield was recorded in the buprofezin 25 SC treated plot (5.4 t ha^{-1}) and was on par with pymetrozine 50 WG (5.2 t ha^{-1}).

Keywords: Brown planthopper, Green miridbugs, Spiders, PD Ratio, Pymetrozine

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Introduction

Rice is a cereal grain, most widely consumed staple food for a large part of the world's human population, especially in Asia. With the continued increase in human population there is a need to increase the rice production per unit of land. Paddy crop in the field is infested by more than hundred insect species, but few causes' significant losses. Losses caused by the insect pests are the main constraint in achieving high yield of rice [1]. In Krishna – Godavari delta regions of Andhrapradesh, the brown planthopper, *Nilaparvata lugens* stal and white backed planthopper, *Sogatella furcifera* Horvarth (Delphacidae: Homoptera) occur both in wet and dry seasons, and imposing substantial damage to the crop [2]. It has a specific herbivore feeding nature with penetrating stylet like mouth parts. Both nymphs and adults suck sap from basal portion of the plant clustering at the base of rice clump which may result in drying up of leaves and wilting of tillers resulting in a condition called "Hopper burn" [3].

The control of this pest has always been emphasized and largely relied on insecticides in most rice producing countries. The indiscriminate use of broad spectrum chemicals also reduce the biodiversity of natural enemies, reduce the natural control and induce outbreak of secondary pests and contaminate eco-system resulting in resurgence of brown planthopper [4]. But still insecticide is the only tool that takes emergency action when the insect population reaches Economic Threshold Level (ETL). Under such circumstances there is a requirement for the development of new insecticide molecules that are selective for target pests [5].

Pymetrozine 50 WG is the insecticide from the pyridine azomethines group with unique mode of action which prevents the insect from inserting the stylet in to the plant tissue (Stylet blocker). The present investigation is carried out to evaluate the efficacy of pymetrozine along with different insecticides against BPH in field conditions.

Materials and Methods

Field experiment was conducted in Agricultural College Farm, Bapatla during kharif 2015. The planthopper susceptible variety Sambha mashuri (BPT 5204) was grown in plot of size 20 m^2 at spacing of 20 x 15 cm with recommended package of practices excluding plant protection for natural infestation of desired pest. The trail was laid out in Randomised Block Design (RBD) with nine treatments including untreated control replicated thrice. The insecticide treatments includes imidacloprid 17.8 SL, thiamethoxam 25 WG, acetamiprid 20 SP, sulfoxaflor 25 SC, dinotefuran 20 SG, pymetrozine 50 WG, buprofezin 25 SC and monocrotophos + dichlorvos 36 SL + 76 EC along with untreated control. The treatments are imposed as and when the pest reaches ETL.

The data on population of BPH and associated natural enemies (miridbugs and spiders) on 10 randomly selected hills from each plot were recorded at one day before the application of treatments, three days after spray and five days after spray. The ratios of BPH and miridbugs, BPH and spiders are calculated.

Statistical analysis

Data were subjected to necessary transformations before statistical analysis and Duncan's Multiple Range Test was applied for comparing the means of treatments [6]. At the time of harvest, grain yield /plot was recorded and converted to kg/ha. Finally the incremental cost benefit ratios are also calculated.

Results and Discussion

A total number of two sprays are given at 15 days interval. Among all the tested insecticides pymetrozine 50 WG was effective in reducing the planthopper population and recorded with 62.98 per cent reduction over untreated control followed by dinotefuran 25 SG and sulfoxaflor 25 SC with 59.60 and 51.99 per cent reduction over untreated control, respectively (**Table 1**). The results are in conformity with findings of [7] who reported that the efficacy of pymetrozine (24 g a.i. ha^{-1}) against BPH after three and seven days after application was 73.69 per cent and 64.92 per cent respectively over control. The treatments monocrotophos + dichlorvos and imidacloprid were found less effective in reducing BPH population with 40.25 and 37.71 per cent but proved effective and significantly superior over untreated control. The present results obtained, pertaining to efficacy of imidacloprid was partly in agreement with those of previous studies that long term use of imidacloprid in a wide range of rice growing areas might be associated with high levels of resistance in *Nilaparvata lugen* [8].

Table 1 Effect of insecticides against Brown planthopper and its associated natural enemies during *kharif* 2015

T. No	Particulars of the insecticides	Per cent reduction of BPH over control	Per cent reduction of Natural enemies over precount		Yield t ha^{-1}
			Miridbugs	Spiders	
1	Imidacloprid 17.8 SL @ 0.25 ml l^{-1}	37.71 (35.19)^{c}	35.51 (33.70)^{bc}	32.06 (32.02)^{c}	4.63^{ab}
2	Thiamethoxam 25 WG @ 0.2 g l^{-1}	45.89 (38.73)^{bc}	27.29 (29.54)^{b}	26.90 (29.33)^{bc}	4.61^{ab}
3	Acetamiprid 20 SP @ 0.2 g l^{-1}	45.42 (38.54)^{bc}	39.62 (35.60)^{c}	29.18 (30.55)^{bc}	4.76^{ab}
4	Sulfoxaflor 25 SC @ 0.75 ml l^{-1}	51.99 (41.18)^{ab}	31.58 (31.78)^{bc}	20.40 (17.94)^{ab}	4.96^{ab}
5	Dinotefuran 20 SG @ 0.4 g l^{-1}	59.60 (44.04)^{a}	27.00 (29.38)^{b}	27.42 (29.61)^{c}	5.28^{a}
6	Pymetrozine 50 WG @ 0.5 g l^{-1}	62.98 (45.26)^{a}	16.96 (23.28)^{a}	23.89 (27.63)^{bc}	5.26^{a}
7	Buprofezin 25 SC @ 1.6 ml l^{-1}	50.70 (40.67)^{abc}	25.13 (28.34)^{b}	25.92 (28.79)^{bc}	5.40^{a}
8	Moncrotophos+Dichlorvos 36 SL + 76 EC @ 2.2 ml l^{-1} + 1 ml l^{-1}	40.25 (36.33)^{bc}	31.71 (30.84)^{bc}	26.41 (29.06)^{bc}	4.13^{b}
9	Untreated control	-	16.55 (23.00)^{a}	9.14 (17.36)^{a}	3.21^{c}
	SEm±	1.928	1.456	1.708	0.274
	Fcal	Significant	Significant	Significant	Significant
	CD (0.05)	5.8	4.4	5.1	0.82
	CV	9.31	8.43	10.62	10.12

Figures in the parentheses are arc sine transformed values
Mean with same letters are not significantly different at 5 % level by Duncan's Multiple Range Test

Natural Enemies

In the experimental location, the following natural enemies that are associated with planthoppers were identified during the track of our experiment (Table 2). Among all the above natural enemies green miridbugs and spiders are abundant. All the insecticides were proved safer to the natural enemies. Among the treatments significantly lowest per cent mortality of green miridbugs was recorded in pymetrozine 50 WG with 16.96 per cent followed by dinotefuran 20 SG and thiamethoxam 25 WG with 27.00 and 27.29 per cent population reduction over precount, respectively. The results were in conformity with the findings of previous workers who reported that pymetrozine @ 125 g a.i. ha^{-1} though exhibited higher toxicity to BPH and WBPH but at the same time relatively less toxic to mirid bugs [9] Significantly the lowest per cent mortality of spiders was recorded in the sulfoxaflor treated plots with 20.40 per cent (**Table 1**). This was in accordance with the DRR 2012 in which it was mentioned that newer molecule sulfoxaflor does not have any impact on spider populations in the field [10].

Table 2 Species associated with planthoppers

Common Name	Scientific Name	Family	Order
Green Miridbugs	*Crytorhinus lividipennis*	Miridae	Homoptera
Wolf spider	*Lycosa pseudoannulata*	Lycosidae	Araneae
Orb Weaver	*Argiope catenulate*	Araneidae	Araneae
Long jawed spider	*Tetragnatha maxillosa*	Tetragnathidae	Araneae
Dragonfly	*Pachydiplax longipennis*	Libellulidae	Odonata

Pest Defender Ratio

Green Miridbugs

The mean population of mirid bugs and BPH per hill ranged from 6.86 to 7.93 and 20.41 to 22.18, respectively before spray and the PD ratio ranged from 1:0.32 to 1:0.37. The mean population of mirid bugs and BPH after spray ranged from 4.25 to 5.90 and 7.53 to 19.86, respectively and their PD ratio ranged from 0.30 to 0.76 (**Table 3**). Among the insecticides tested, pymetrozine 50 WG (1: 0.76) and dinotefuran 20 SG (1:0.61) were much safer followed by buprofezin 20 SP (1:0.51) and sulfoxaflor 25 SC (1:0.49). The insecticide pymetrozine 50 WG (1:0.08) and sulfoxaflor 25 SC (1:0.07) occupied the first two places in safety to spiders as per PD ratios and are on par with each other (**Table 4**).

The pest defender ratio was more after spray which indicates that the insecticides exerted less impact on natural enemies and resulted in suppression of pest population. The pest defender ratio in pymetrozine was more because of its effectiveness against BPH and safety to natural enemies like green mirid bugs and spiders.

Table 3 Effect of new insecticide molecules on the population of green mirid bugs and their PD ratio during *kharif* 2015

T. No	Particulars of the insecticides	Mean population of miridbugs per hill					
		Before spray			After Spray		
		Miridbugs	BPH	PD ratio	Miridbugs	BPH	PD ratio
1	Imidacloprid 17.8 SL @ 0.25 ml l^{-1}	7.05	20.41	0.35	4.35 (2.09)^{b}	11.85	0.37
2	Thiamethoxam 25 WG @ 0.2 g l^{-1}	6.90	21.13	0.33	5.09 (2.26)^{ab}	10.67	0.48
3	Acetamiprid 20 SP @ 0.2 g l^{-1}	7.93	21.50	0.37	4.25 (2.06)^{b}	10.92	0.39
4	Sulfoxaflor 25 SC @ 0.75 ml l^{-1}	6.86	21.27	0.32	4.59 (2.14)^{b}	9.46	0.49
5	Dinotefuran 20 SG @ 0.4 g l^{-1}	7.18	22.18	0.32	5.14 (2.27)^{ab}	8.44	0.61
6	Pymetrozine 50 WG @ 0.5 g l^{-1}	6.88	21.82	0.32	5.72 (2.39)^{a}	7.53	0.76
7	Buprofezin 25 SC @ 1.6 ml l^{-1}	7.31	21.35	0.34	5.03 (2.24)^{ab}	9.78	0.51
8	Moncrotophos+Dichlorvos 36 SL + 76 EC @ 2.2 ml l^{-1} + 1 ml l^{-1}	7.01	21.55	0.33	5.15 (2.27)^{ab}	11.98	0.43
9	Untreated control	7.23	21.33	0.34	5.90 (2.43)^{a}	19.86	0.30
	SEm±	0.130			0.074		
	Fcal	NS			Sig		
	CD	-			0.22		
	CV	8.49			5.73		

Sig – Significant NS – Non Significant

Figures in the parentheses are square root transformed values

Mean with same letters are not significantly different at 5 % level by Duncan's Multiple Range Test.

P : D Ratio – Pest Defender Ratio

Grain yield

During *Kharif* 2015 all the treatments recorded significantly higher grain yields over the untreated control. Among the treatments, buprofezin 25 SC was significantly superior over the other treatments and recorded grain yield of 5400 kg ha^{-1} with 67.98 per cent yield increase over the untreated control followed by pymetrozine 50 WG (5266 kg ha^{-1}) with 63.81 per cent yield increase over untreated control and were on par with each other. Among the treatments monocrotophos + dichlorvos recorded less yield with yield increase of 28.57 per cent but superior over control. With regard to Incremental Cost Benefit Ratio it ranged from 1:0.54 to 1:1.45. The highest ICBR was recorded with pymetrozine (1.45) followed by dinotefuran (1.43), buprofezin (1.35), acetamiprid (1.25), sulfoxaflor (1.23). imidacloprid (1.18), thiamethoxam (1.17), monocrotophos + dichlorvos (0.90).

Table 4 Effect of new insecticide molecules on the population of spiders and their PD ratio during *kharif* 2015

T. No	Particulars of the insecticides	Mean population per 10 hills					
		Before spray			After spray		
		Spiders	BPH	P D ratio	Spiders	BPH	P D ratio
1	Imidacloprid 17.8 SL @ 0.25 ml l^{-1}	8.26	204.10	0.04	6.33 (2.52)^b	118.5	0.05
2	Thiamethoxam 25 WG @ 0.2 g l^{-1}	7.56	211.30	0.04	6.53 (2.56)^a	106.70	0.06
3	Acetamiprid 20 SP @ 0.2 g l^{-1}	5.83	215.00	0.03	5.26 (2.29)^b	109.20	0.05
4	Sulfoxaflor 25 SC @ 0.75 ml l^{-1}	6.35	212.65	0.03	6.33 (2.52)^b	94.60	0.07
5	Dinotefuran 20 SG @ 0.4 g l^{-1}	6.40	221.80	0.03	5.43 (2.33)^b	84.40	0.06
6	Pymetrozine 50 WG @ 0.5 g l^{-1}	6.88	218.15	0.03	6.20 (2.49)^b	75.30	0.08
7	Buprofezin 25 SC @ 1.6 ml l^{-1}	6.74	213.50	0.03	5.03 (2.25)^b	97.80	0.05
8	Moncrotophos+Dichlorvos 36 SL + 76 EC @ 2.2 ml l^{-1} + 1 ml l^{-1}	7.04	215.45	0.03	5.00 (2.24)^b	119.80	0.04
9	Untreated control	6.85	213.30	0.03	6.83 (2.61)^a	198.60	0.03
	SEm±	0.182			0.088		
	Fcal	NS			Sig		
	CD (0.05)	-			0.3		
	CV (%)	11.50			6.31		

Sig – Significant, NS – Non Significant
Figures in parentheses are square root transformed values
Mean with same letters are not significantly different at 5 % level by Duncan's Multiple Range Test.
P:D ratio – Pest Defender ratio

Conclusions

It is evident from the present investigation that pymetrozine 50 SG is effective against *Nilaparvata lugens* and is very safe to the important predators fauna recorded in rice eco-system and recorded with higher PD ratio. Eventhough highest yield was recorded in the buprofezin treated plots but it was on par with pymetrozine. The highest cost benefit ratio was found in the pymetrozine treated plots.

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