Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2019; 7(5): 860-865

Received: 19-07-2019
Accepted: 23-08-2019

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Bio-efficacy and phytotoxicity of novel insecticides agianst brown plant hopper (Stal.), *Nilaparvata lugens* (Hemiptera: delhacidae) on rice

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Abstract

To study the bio-efficacy and phytotoxicity of novel insecticides against Brown Plant Hopper, *Nilaparvata lugens* in rice crop, trials were conducted at Agricultural Research Station, Kampasagar, Nalgonda District, Telangana during *Kharif* 2016 and 2017. Eight treatments *i.e.* Sulfoxaflor 24 SC @ 375 ml/ha, different dosages of Pymetrozine 50 WG @ 250 g/ha, 300 g/ha (GSP sample), 300 g/ha (Market standard) and 350 g/ha, Thiomethoxam 25 WG @ 100 g/ha and Buprofezin 25 SC @ 800 ml/ha and control were imposed in Randomized Block Design with three replications. The overall mean of BPH population prior to one day before spraying was found to be non significant. BPH population was low on Sulfoxaflor 24 SC @ 375 ml/ha and Pymetrozine 50 WG @ 350 g/ha followed by Pymetrozine 50 WG @ 300 g/ha (market standard), 300 g/ha (GSP sample), 250 g/ha, Thiomethoxam 25 WG @ 100 g/ha and Buprofezin 25 SC @ 800 ml/ha and were found to be on par to each other and superior to control at 1, 3, 5, 7 and 10 days after first spraying and similar trend was also noticed after second spraying. The highest grain yield was recorded on Sulfoxaflor 24 Sc @ 375 ml/ha and Pymetrozine 50 WG @ 350 g/ha which were on par to each other and remaining treatments had grain yield either low or high over the control. The phytotoxicity was not observed at 1, 3, 5, 7 and 10 days after spraying of single dose and double dosages of Pymetrozine 50 WG @ 375 g/ha.

Keywords: Rice, brown plant hopper, insecticides, yield, phytotoxicity

1. Introduction

Globally among the rice growing countries and in India, Brown Plant Hopper (BPH) *Nilaparvata lugens* (Stal) (Hemiptera: Delphacidae) a serious pest on rice. It is a monophaghous pest causing severe damage to rice plants, frequently severe outbreaks have occurred in several parts of the country and economic yield losses ranged from 10 to 90 per cent [1]. Both nymphs and adults cause severe damage to rice crop by sucking the sap at the base of the plant resulting "Hopper burn" symptom.

Growing BPH susceptible fine grain rice varieties and hybrids under assured irrigation facilities, monocropping, staggered plantings, high dosage and indiscriminate use of insecticides resulted in severe outbreak of pest in thousands of acres in Nalgonda District of Telangana state in India over the past 6-8 years causing maximum yield losses [2].

In any crop ecosystem, chemical control is one of the most effective management tools and an important component in Integrated Pest Management. Extensive use of broad spectrum insecticides on large scale reduces the biodiversity of natural enemies, outbreak secondary pest infestation and thus contaminating ecosystem [3]. Predominantly synthetic chemicals are used to control BPH for many years and high resistance developed to BPH against chemical insecticides i.e. neonicotinoids [4] and it has become a serious threat in rice production [5, 6]. However, due to large scale and extensive use of insecticides, BPH has evolved high level of resistance and resurgence to the major classes of insecticides. Hence, there is a need to evaluate new molecules of insecticides from time to time. Therefore, the present investigation was carried out with the following objectives:

1. To evaluate the Bio-efficacy of certain insecticide molecules against Brown Plant Hopper (BPH) on Rice.
2. To evaluate the Phytotoxicity of Pymetrozine 50% WG on Rice.

2. Materials and Methods

Trials were conducted at Agricultural Research Station, Kampasagar, Nalgonda District, Telangana during *Kharif* 2016 and 2017 on tested variety BPT- 5204. Eight treatments including control were evaluated in RBD with three replications. Seedlings were transplanted 25 days after sowing with inter and intra row spacing of 15 x 10 cm. The fertilizers N: P: K were used at 120:60:40 kg/ha and applied entire P_2O_5 and K_2O as a basal, while 'N_2' in three equal splits. All the agronomic practices were followed as per the recommended package of practices except insecticidal spraying schedule. The treatments include Pymetrozine 50% WG @ 250, 300 and 350 g/ha, market standard of Pymetrozine 50% WG @ 300 g/ha, Thiomethoxam 25% WG @ 100 g/ha and Buprofezin 25% SC @ 800 ml/ha, Sulfoxaflor 24% SC @ 375 ml/ha and control. Based on ETL three sprayings in each treatment were imposed i.e. first spray at 55 DAT and an interval of 10 days after each spray. The data on number of plant hoppers (BPH) were collected on 20 randomly selected plant hills from each plot at one day before and 1, 3, 5, 7 and 10 days after the spray. The grain yields were collected from each net plot and converted to q/ha.

Phytotoxicity was assessed by visual observation. Ten plants each in Pymetrozine 150 g/ha, Pymetrozine 300 g/ha and control treatments in all three replications were observed critically at 0, 1, 3, 5, 7 and 10 days after spraying for Chlorosis, leaf tip burning, Necrosis, Epinasty, Hyponasty, Vein clearing, Scorching and Wilting were graded on 0-10 point phytotoxicity scale. (Scale (0-10): 0=00, 1= 1-10%, 2= 11-20%, 3= 21-30%, 4=31-40%, 5=41-50%, 6=51-60%, 7=61-70%, 8=71-80%, 9= 81-90%, 10= 91-100%). Data was statistically analyzed by ANOVA using OPSTAT with square root transformation.

3. Results and Discussion

The data generated on population of BPH in terms of numbers per hill at pre treatment periods during *Kharif* 2016 and 2017 revealed that range of BPH population one day prior to spraying was 25.0 to 35.0 hoppers per hill during *Kharif* 2016 and 155.6 to 256.6 hoppers per hill during 2017. Based on mean population of BPH in both the seasons, range was 92.4 to 143.8 hoppers per hill (Table 1). Hence, non significance among the treatments for BPH population was noticed.

During 2016, one day after spraying low BPH population 19.5 hoppers/hill was observed on Pymetrozine 50 WG @ 350 g/ha which was on par to Pymetrozine 50 WG @ 300 g/ha (GSP sample), 300 g/ha (market standard), Sulfoxaflor 24 SC @ 375 g/ha and Buprofezin 25 SC @ 800 ml/ha. At 3 days after spray, treatment Sulfoxaflor 24 SC @ 375 ml/ha recorded low BPH population (17.0 hoppers/hill) followed by Pymetrozine 50 WG @ 350 g/ha (17.4 hoppers/hill), 300 g/ha (market standard) (18.4 hoppers/hill) and 300 g/ha (GSP sample), (18.6 hoppers/hill) respectively and all these treatments were on par with each other and significantly differed from other treatments (Table 1). Similar trend was observed at 5, 7 and 10 days after spray (Table 2).

At after one day spray during 2017, Sulfoxaflor 24 SC @ 375 ml/ha and Pymetrozine 50 WG @ 350 g/ha recorded low BPH population (160.2 and 171.6 hoppers/hill) and were on par to each other followed by Pymetrozine 50 WG @ 300 g/ha (market standard), 300 g/ha (GSP sample), 250 g/ha, Thiomethoxam 25 WG @ 100 g/ha and Buprofezin 25 SC @ 800 ml/ha (195.4, 210.5, 215.9, 202.4 and 237.4 hoppers/hill, respectively) and these five treatments were found to be on par with each other. High BPH population was recorded on control (253.3 hoppers/hill) (Table 1). The low BPH population was recorded on Sulfoxaflor 24 SC @ 375 ml/ha (140.7 hoppers/hill) but it was on par with Pymetrozine 50 WG @ 350 g/ha (153.7 hoppers/hill) followed by Pymetrozine 50 WG @ 300 g/ha (market standard), 300 g/ha (GSP sample) 167.6 and 169.7 hoppers/hill, respectively. Pymetrozine 50 WG @ 250 g/ha (180.7 hoppers/hill), Buprofezin 25 SC @ 800 ml/ha (185.7 hoppers/hill) and Thiomethoxam 25 WG @ 100 g/ha (186.1 hoppers/hill) and were on par with each other. BPH population was high in control 269.7 hoppers/hill at 3 DAS (Table 1) and same trend was observed at 5 and 7 days after spray. At 10 DAS, Sulfoxaflor 24 SC @ 375 ml/ha observed low population of BPH (87.9 hoppers/hill) and significant from the remaining insecticidal treatments and control (Table 2).

Based on overall mean of both the seasons at 1 day after spray, the treatment Sulfoxaflor 24 SC @ 375 ml/ha had shown low BPH population (90.8 hoppers/hill) followed by Pymetrozine 50 WG @ 350 g/ha (95.6 hoppers/hill) and were on par to each other. Next best effective treatments were Pymetrozine 50 WG @ 300 g/ha (market standard), Thiomethoxam 25 WG @ 100 g/ha, Pymetrozine 50 WG @ 300 g/ha (GSP sample) and 250 g/ha, 108.3, 112.8, 115.7 and 121.9 hoppers/hill, respectively, but these were at par with each other followed by Buprofezin 25 SC @ 800 ml/ha (132.8 hoppers/hill). However, the highest BPH population was recorded on control (137.5 hoppers/hill) (Table 1).

The Sulfoxaflor 24 SC @ 375 ml/ha recorded low BPH population (78.9 hoppers/hill) and was on par with Pymetrozine 50 WG @ 350 g/ha (85.6 hoppers/hill) and superior to remaining treatments at three days after spray (Table 1) and similar trend was observed at 5 days after spray. At 7 days after spray, the Sulfoxaflor 24 SC @ 375 ml/ha (94.1 hoppers/hill) was found to be significantly superior over the remaining treatments. Next most effective treatments were Pymetrozine 50 WG @ 350 g/ha, 300 g/ha (market standard) and 300 g/ha (GSP sample), 68.7, 75.0 and 76.5 hoppers/hill, respectively, but these were at par with each other followed by Thiomethoxam 25 WG @ 100 g/ha (81.7 hoppers/hill) which was equally effective with Pymetrozine 50 WG @ 250 g/ha (82.4 hoppers/hill) and Buprofezin 25 SC @ 800 ml/ha (83.7 hoppers/hill) as compared to the control (163.6 hoppers/hill). After 10 days after spray, the efficacy of insecticides varied and subsequently a decrease in BPH population in various treatments. Significantly low BPH population was recorded in Sulfoxaflor 24 SC @ 375 ml/ha (51.2 hoppers/hill) followed by Pymetrozine 50 WG @ 350 g/ha, 300 g/ha (GSP sample), 300 g/ha (market standard), 250 g/ha, Buprofezin 25 SC @ 800 ml/ha 62.6,63.7, 65.3, 68.2 and 69.6 hoppers/hill, respectively, but these treatments were on par with each other, followed by Thiomethoxam 25 WG @ 100 g/ha (70.5 hoppers/hill). The high BPH population was observed on control (169.9 hoppers/hill) (Table 2) and similar trend was also observed on 2nd spraying (Table 3). Similarly earlier researchers reported that, Sulfoxaflor 24 SC at higher doses controlled sucking pests in rice [7] and good spectrum of action against BPH and no resurgence was observed on pest population [8]. Sulfoxaflor had effectively controlled BPH population as it targets on central nervous system of the insect as agonist nicotinic acetylcholine receptors and higher sensitivity and better performance on sucking insects [12] and another findings Sulfoxaflor 24 SC @ 75 g a.i/ha and 82 and 68 g/ha and also observed lower the BPH population [13,14].

Table 1: Comparative efficacy of Pymetrozine 50% WG against Brown Plant hopper (*Nilaparvata lugens*) on Rice during *Kharif*- 2016 and 2017 at ARS, Kampasagar, Nalgonda district

Treatment	a.i. (g)/ha	Formulation (g or ml) /ha	1st spray (Brown Plant hopper (Average no.s /20 Plant hills))								
			PTC			1 DAS			3 DAS		
			2016	2017	Mean	2016	2017	Mean	2016	2017	Mean
T1-Pymetrozine 50% WG	125	250	31.0 (5.6±0.1)bcd	256.6 (16.0±0.5)	143.8 (12.0±0.3)	27.9 (5.4±0.0)c	215.9 (14.8±0.1)b	121.9 (11.1±0.1)cd	25.1 (5.1±0.0)c	180.7 (13.4±0.0)c	102.9 (10.2±0.0)cd
T2-Pymetrozine 50% WG (GSP Sample)	150	300	29.2 (5.4±0.1)abcd	155.6 (12.3±1.5)	92.4 (9.6±1.0)	20.9 (4.7±0.0)ab	210.5 (14.5±0.1)b	115.7 (10.8±0.1)c	18.6 (4.4±0.0)a	169.7 (13.0±0.1)bc	94.2 (9.8±0.1)bcd
T3-Pymetrozine 50% WG	175	350	30.6 (5.6±0.1)bcd	206.7 (14.4±0.4)	118.6 (10.9±0.3)	19.5 (4.5±0.1)a	171.6 (13.1±0.4)ab	95.6 (9.8±0.3)ab	17.4 (4.3±0.0)a	153.7 (12.4±0.1)ab	85.6 (9.3±0.1)ab
T4-Pymetrozine 50% WG (Market standard)	150	300	35.0 (5.9±0.1)d	213.3 (14.4±1.7)	124.2 (11.1±1.1)	21.2 (4.7±0.0)ab	195.4 (14.0±0.3)b	108.3 (10.5±0.2)c	18.4 (4.4±0.0)a	167.6 (12.7±0.4)bc	92.3 (9.7±0.3)bc
T5-Thiomethoxam 25% WG	25	100	29.2 (5.4±0.3)abcd	245.7 (15.7±0.2)	137.4 (11.8±0.2)	23.2 (4.9±0.1)b	202.4 (14.2±0.1)b	112.8 (10.7±0.2)c	23.1 (4.9±0.0)bc	186.1 (13.6±0.0)c	104.6 (10.3±0.1)d
T6-Buprofezin 25% SC	200	800	26.8 (5.2±0.1)abc	216.7 (14.5±1.6)	121.8 (11.0±1.1)	21.7 (4.8±0.0)ab	237.4 (15.4±0.1)bc	132.8 (11.6±0.1)de	20.6 (4.7±0.0)b	185.7 (13.6±0.0)c	103.2 (10.2±0.0)cd
T7-Sulfoxaflor 24%SC	24	375	25.6 (5.1±0.0)ab	199.8 (14.0±1.1)	112.7 (10.6±0.8)	21.3 (4.7±0.0)ab	160.2 (12.6±0.1)a	90.8 (9.6±0.1)a	17.0 (4.2±0.0)a	140.7 (11.8±0.2)a	78.9 (8.9±0.2)a
T8- Control			25.0 (5.0±0.1)a	225.9 (15.0±0.2)	125.5 (11.2±0.2)	28.3 (5.4±0.0)c	253.3 (15.9±0.5)c	137.5 (11.8±0.4)e	29.7 (5.5±0.0)d	269.7 (16.4±0.2)d	149.7 (12.3±0.1)e
C.D. (p=0.05)			0.5	NS	N.S	0.3	1.0	0.6	0.2	0.7	0.5
SE(m)±			0.2	0.9	0.6	0.1	0.3	0.2	0.0	0.2	0.2
SE(d)			0.2	1.3	0.8	0.1	0.4	0.3	0.1	0.3	0.2
CV (%)			5.2	10.9	9.4	3.0	3.8	3.4	1.8	2.9	2.6

Figures in parenthesis are square root transformed values; Figures in a column followed by same letter are not significantly different at P=0.05 DAS=Days after spraying; NS= Non significant

Table 2: Comparative efficacy of Pymetrozine 50% WG against Brown Plant hopper (*Nilaparvata lugens*) on Rice during *Kharif*- 2016 and 2017 at ARS, Kampasagar, Nalgonda district.

Treatment	a.i. (g)/ha	Formulation (g or ml) /ha	5 DAS			7 DAS			10 DAS		
			2016	2017	Mean	2016	2017	Mean	2016	2017	Mean
T1-Pymetrozine 50% WG	125	250	23.8 (5.0±0.0)c	153.8 (12.4±0.2)cd	88.8 (9.5±0.2)cd	23.3 (4.9±0.0)c	141.5 (11.9±0.3)cd	82.4 (9.1±0.2)c	21.7 (4.8±0.0)d	114.7 (10.7±0.0)b	68.2 (8.3±0.0)bc
T2-Pymetrozine 50% WG (GSP Sample)	150	300	17.3 (4.3±0.0)a	149.9 (12.2±0.1)bcd	83.6 (9.2±0.1)bc	16.7 (4.2±0.0)a	136.4 (11.7±0.0)bcd	76.5 (8.8±0.0)bc	16.3 (4.2±0.0)ab	111.1 (10.5±0.0)b	63.7 (8.0±0.0)b
T3-Pymetrozine 50% WG	175	350	16.2 (4.1±0.0)a	134.5 (11.6±0.2)ab	75.3 (8.7±0.2)ab	15.9 (4.1±0.0)a	121.5 (11.0±0.4)b	68.7 (8.3±0.3)b	14.9 (4.0±0.0)a	110.4 (10.5±0.4)b	62.6 (8.0±0.3)b
T4-Pymetrozine 50% WG (Market standard)	150	300	16.7 (4.2±0.0)a	142.1 (11.9±0.1)bc	79.4 (9.0±0.1)bc	16.3 (4.2±0.0)a	133.8 (11.6±0.0)bc	75.0 (8.7±0.1)bc	15.3 (4.0±0.0)a	115.3 (10.7±0.1)b	65.3 (8.1±0.1)bc
T5-Thiomethoxam 25% WG	25	100	22.9 (4.9±0.0)bc	165.6 (12.9±0.2)d	94.2 (9.8±0.2)d	21.3 (4.7±0.0)bc	142.2 (11.9±0.1)cd	81.7 (9.1±0.1)c	19.9 (4.6±0.0)cd	121.1 (11.0±0.2)b	70.5 (8.5±0.1)c
T6-Buprofezin 25% SC	200	800	20.7 (4.7±0.0)b	158.1 (12.6±0.2)cd	89.4 (9.5±0.1)cd	20.0 (4.6±0.1)b	147.4 (12.1±0.2)cd	83.7 (9.2±0.2)c	18.7 (4.4±0.0)bc	120.4 (11.0±0.2)b	69.6 (8.4±0.2)bc
T7-Sulfoxaflor 24%SC	24	375	15.7 (4.1±0.1)a	117.5 (10.8±0.1)a	66.6 (8.2±0.1)a	15.0	94.1 (9.7±0.0)a	54.5 (7.5±0.1)a	14.5	87.9 (9.4±0.0)a	51.2 (7.2±0.1)a

						(4.0±0.2)a			(3.9±0.2)a		
T8- Control			30.8 (5.6±0.0)d	280.3 (16.7±0.2)e	155.6 (12.5±0.2)e	31.7 (5.7±0.0)d	295.3 (17.2±0.2)e	163.6 (12.8±0.2)d	32.4 (5.8±0.0)e	307.5 (17.5±0.1)c	169.9 (13.1±0.1)d
C.D. (p=0.05)			0.2	0.7	0.5	0.2	0.7	0.5	0.3	0.6	0.4
SE(m)±			0.1	0.2	0.2	0.1	0.2	0.1	0.1	0.2	0.1
SE(d)			0.1	0.3	0.2	0.1	0.3	0.2	0.1	0.3	0.2
CV (%)			2.4	3.1	2.8	3.1	3.2	2.8	3.4	3.1	2.7

Figures in parenthesis are square root transformed values; Figures in a column followed by same letter are not significantly different at P=0.05; DAS=Days after spraying; NS= Non significant

Table 3: Comparative efficacy of Pymetrozine 50% WG against Brown Plant hopper (*Nilaparvata lugens*) on Rice during *Kharif*- 2016 and 2017 at ARS, Kampasagar, Nalgonda district

Treatment	a.i. (g/ ha	Formulation (g or ml) /ha	2nd spray (Brown Plant hopper (Average no's /20 Plant hills))														
			1 DAS			3 DAS			5 DAS			7 DAS			10 DAS		
			2016	2017	Mean	2016	2017	Mean	2016	2017	Mean	2016	2017	Mean	2016	2017	Mean
T1-Pymetrozine 50% WG	125	250	**18.7 (4.4±0.1)d**	**5.6 (2.5±0.2)a**	**12.1 (3.6±0.1)cde**	**17.8 (4.3±0.0)d**	**4.3 (2.3±0.1)a**	**11.0 (3.5±0.0)c**	**16.6 (4.2±0.0)cd**	**4.4 (2.4±0.2)a**	**10.7 (3.4±0.1)b**	**16.0 (4.1±0.0)e**	**0.7 (1.3±0.0)ab**	**8.4 (3.1±0.0)d**	**15.0 (4.0±0.0)e**	**0.6 (1.3±0.0)a**	**7.8 (3.0±0.0)d**
T2-Pymetrozine 50% WG (GSP Sample)	150	300	14.2 (3.9±0.3)abc	6.5 (2.7±0.1)a	10.4 (3.4±0.1)bcd	14.1 (3.9±0.1)b	3.9 (2.2±0.0)a	9.0 (3.2±0.1)b	10.8 (3.4±0.1)ab	5.0 (2.3±0.3)a	7.7 (2.9±0.1)a	10.9 (3.5±0.0)c	0.6 (1.3±0.0)ab	5.7 (2.6±0.0)b	10.7 (3.4±0.0)c	0.5 (1.2±0.0)a	5.6 (2.6±0.0)c
T3-Pymetrozine 50% WG	175	350	12.7 (3.7±0.1)ab	5.3 (2.5±0.2)a	9.0 (3.2±0.1)ab	11.4 (3.5±0.1)a	3.8 (2.2±0.1)a	7.6 (2.9±0.0)a	9.9 (3.3±0.0)ab	3.5 (2.1±0.2)a	6.7 (2.8±0.1)a	9.6 (3.3±0.0)b	0.5 (1.2±0.0)a	5.0 (2.5±0.0)ab	9.4 (3.2±0.0)ab	0.5 (1.2±0.0)a	4.9 (2.4±0.0)ab
T4-Pymetrozine 50% WG (Market standard)	150	300	14.8 (4.0±0.0)bcd	5.7 (2.6±0.1)a	10.2 (3.3±0.0)abc	14.7 (4.0±0.0)bc	4.3 (2.3±0.0)a	9.5 (3.2±0.0)b	10.6 (3.4±0.0)ab	5.1 (2.4±0.3)a	7.8 (3.0±0.1)a	9.9 (3.3±0.0)b	0.6 (1.3±0.0)ab	5.3 (2.5±0.0)ab	9.6 (3.3±0.0)bc	0.6 (1.3±0.0)a	5.1 (2.5±0.0)bc
T5-Thiomethoxam 25% WG	25	100	17.6 (4.3±0.1)cd	6.7 (2.8±0.2)a	12.1 (3.6±0.1)cde	16.9 (4.2±0.0)	4.7 (2.4±0.1)a	10.8 (3.4±0.1)bc	17.3 (4.3±0.1)d	3.9 (2.2±0.2)a	10.6 (3.4±0.1)b	16.4 (4.2±0.1)e	0.8 (1.4±0.1)b	8.6 (3.1±0.0)d	15.8 (4.1±0.0)e	0.6 (1.2±0.1)a	8.2 (3.0±0.0)d
T6-Buprofezin 25% SC	200	800	16.7 (4.2±0.1)cd	9.4 (3.2±0.0)b	13.1 (3.8±0.0)e	15.4 (4.1±0.0)bcd	8.0 (3.0±0.0)b	11.7 (3.6±0.0)c	15.1 (4.0±0.1)c	7.7 (2.9±0.0)b	11.4 (3.5±0.1)b	14.4 (3.9±0.1)d	0.9 (1.4±0.0)b	7.6 (2.9±0.1)c	13.7 (3.8±0.1)d	0.7 (1.3±0.0)a	7.2 (2.9±0.0)d
T7-Sulfoxaflor 24%SC	24	375	11.1 (3.5±0.1)a	5.2 (2.5±0.1)a	8.2 (3.0±0.0)a	9.6 (3.3±0.0)a	4.2 (2.3±0.1)a	6.9 (2.8±0.0)a	9.3 (3.2±0.0)a	4.4 (2.3±0.1)a	6.9 (2.8±0.0)a	8.7 (3.1±0.0)a	0.5 (1.2±0.0)a	4.6 (2.4±0.0)a	8.5 (3.1±0.0)a	0.4 (1.2±0.0)a	4.5 (2.3±0.0)a
T8- Control			33.4 (5.8±0.1)e	56.1 (7.6±0.2)c	44.8 (6.8±0.1)f	34.0 (5.9±0.0)e	60.8 (7.9±0.2)c	47.4 (7.0±0.1)d	34.4 (6.0±0.1)e	65.3 (8.1±0.0)c	49.9 (7.1±0.0)c	35.6 (6.1±0.1)f	67.3 (8.3±0.0)c	51.5 (7.2±0.0)e	36.7 (6.1±0.1)f	69.3 (8.4±0.0)b	53.0 (7.3±0.0)e
C.D. (p=0.05)			0.4	0.4	0.3	0.2	0.3	0.2	0.2	0.5	0.2	0.1	0.1	0.1	0.1	0.1	0.1
SE(m)±			0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.0	0.0	0.0	0.0	0.0
SE(d)			0.2	0.2	0.1	0.1	0.2	0.1	0.1	0.2	0.1	0.1	0.0	0.0	0.1	0.1	0.0
CV (%)			4.9	7.5	4.2	2.3	6.1	2.8	2.2	8.9	3.5	2.1	2.8	1.8	2.1	3.5	1.6

Figures in parenthesis are square root transformed values; Figures in a column followed by same letter are not significantly different at P=0.05; DAS=Days after spraying; NS= Non significant

Table 4: Paddy grain yield in various treatments during *Kharif* 2016 and 2017

Treatment	a.i. (g)/ha	Formulation (g or ml) /ha	Grain Yield (q/ha)	
			2016	2017
T1-Pymetrozine 50% WG	125	250	53.3f	57.4bc
T2-Pymetrozine 50% WG (GSP Sample)	150	300	58.0bc	56.3cde
T3-Pymetrozine 50% WG	175	350	60.8ab	60.5b
T4-Pymetrozine 50% WG (Market standard)	150	300	57.8bcd	56.3cde
T5-Thiomethoxam 25% WG	25	100	57.5bcde	56.7cd
T6-Buprofezin 25% SC	200	800	54.2cdef	53.7de
T7-Sulfoxaflor 24%SC	24	375	63.8a	64.5a
T8- Control			40.3g	41.3f
C.D. (p=0.05)			3.9	3.5
SE(m)±			1.3	1.2
SE(d)			1.8	1.6
CV (%)			3.9	3.6

Figures in a column followed by same letter are not significantly different at P=0.05

Table 5: Phytotoxicity testing of pymetrozine 50% WG on Rice during *Kharif*, 2016 and 2017 a) phytotoxicity data on chlorosis & vein clearing

		Dosage/ha (g)		Days of observation					
S. No	Treatments	a.i.	Formulation	0	1	3	5	7	10
1.	Pymetrozine 50% WG	150	300	0	0	0	0	0	0
2.	Pymetrozine 50% WG	300	600	0	0	0	0	0	0
3.	Control	-	-	0	0	0	0	0	0

b) Phytotoxicity data on Wilting & Necrosis

		Dosage/ha (g)		Days of observation					
S. No	Treatments	a.i.	Formulation	0	1	3	5	7	10
1.	Pymetrozine 50% WG	150	300	0	0	0	0	0	0
2.	Pymetrozine 50% WG	300	600	0	0	0	0	0	0
3.	Control	-	-	0	0	0	0	0	0

c) Phytotoxicity data on Scorching & Leaf tip burning

		Dosage/ha (g)		Days of observation					
S. No	Treatments	a.i.	Formulation	0	1	3	5	7	10
1.	Pymetrozine 50% WG	150	300	0	0	0	0	0	0
2.	Pymetrozine 50% WG	300	600	0	0	0	0	0	0
3.	Control	-	-	0	0	0	0	0	0

d) Phytotoxicity data on Epinasty and Hyponasty

S. No	Treatments	Dosage/ha (g)		Days of observation					
		a.i.	Formulation	0	1	3	5	7	10
1.	Pymetrozine 50% WG	150	300	0	0	0	0	0	0
2.	Pymetrozine 50% WG	300	600	0	0	0	0	0	0
3.	Control	-	-	0	0	0	0	0	0

Scale (0-10):0=00, 1= 1-10%, 2= 11-20%, 3= 21-30%, 4=31-40%, 5=41-50%, 6=51-60%, 7=61-70%, 8=71-80%, 9= 81-90%, 10= 91-100%.

Pymetrozine 50 WG was reduced the BPH population and found quite effective against plant hoppers in rice [9, 10]. Low incidence of BPH and high grain yield recorded on Pymetrozine 50 WG @ 0.5 g/L in rice [11].

4. Yield

All the treatments resulted in higher grain yield and proved significantly superior over control during both the seasons of 2016 and 2017. The grain yield in Sulfoxaflor 24 SC @ 375 ml/ha was high 63.8 q/ha and 64.5 q/ha, respectively during *Kharif* 2016 and 2017 followed by Pymetrozine 50 WG @ 350 g/ha (60.8 q/ha and 60.5 q/ha, respectively). The yields in other treatments were comparatively low, but more than control (Table 4). Similarly earlier workers also observed Sulfoxaflor 24 SC @ 876 ml/ha and Pymetrozine 50 WG @ 400 g/ha was recorded maximum grain yield [7, 15].

5. Phytotoxicity

The data regarding phototoxic effects such as injury on Leaf chlorosis, leaf tip burning, Leaf necrosis, Epinasty, Hyponasty, Scorching, Vein clearing and Wilting at 0, 1, 3, 5, 7 and 10 days after spraying revealed that Pymetrozine 50% WG @ 350 g/ha even at its higher dose did not show any phytotoxicity symptoms on rice during both seasons (Table 5a, b, c, d). Similar findings also noticed in Pymetrozine 50 % WG @ 600 g/ha [15] and Pymetrozine 50 WG @ 350 g a.i/ha [10].

6. Conclusion

The results revealed that Sulfoxaflor 24 SC @ 375 ml/ha followed by Pymetrozine 350 g/ha were effectively controlled BPH in rice. Application of treatments resulted in non phytotoxicity on rice and no adverse effects on natural enemies. Hence, these two insecticides were proved to be best management of BPH and these could be involved in integrated pest management strategies to mitigate the problems of farming community.

7. References

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