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Field evaluation of novel insecticides against brown planthopper (*Nilaparvata lugens*) and white backed planthopper (*Sogatella furcifera*) in rice

S S DHAKA[1], MONIKA RAI[2], M RAI[3] and A YADAV[4]

Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, and Krishi Vigyan Kendra, Pilibhit, Uttar Pradesh

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ABSTRACT

A field experiment was conducted to evaluate the bioefficacy of novel insecticides against brown planthopper [*Nilaparvatha lugens* (Stal)] (BPH) and white backed planthopper [*Sogatella furcifera* (Hoverth)] (WBPH) on rice. The results revealed that field application of triflumezopyrim 10 SC @ 235 ml per ha was found superior and registered 1.88 and 1.26 hoppers per hill against BPH and WBPH followed bypymetrozine 50 WG @ 300g per ha with 2.12 and 1.26 hoppers of BPH and WBPH per hill, respectively. The response of these insecticides was also observed on the yield attributes, with highest grain yield of 55.58 q/ha in triflumezopyrim 10 SC @ 235 ml per ha followed by pymetrozine 50 WG @ 300 g per ha (53.79 q/ ha).

Key words: *Nilaparvata lugens*, Pymetrozine, Rice, *Sogatella furcifera*, Triflumezopyrim

Rice (*Oryza sativa* L.) is an important food crop for more than two third of the population of India and accounts for more than 50% of the daily calorie intake (Khush 2005). Low productivity in rice is attributed by many factors. Among so many biotic and abiotic constraints of rice production insect, mite and nematode pests are the key biotic stresses limiting rice production in India, while Kalode and Pasalu (1986) reported that over 100 species of insect pests attack the rice crop at various stages of its growth, of which 20 are economically important. Approximately 21% of the global production losses of rice are attributed to the attack of insect pests (Yarasi *et al*. 2008). Among the major insect pests brown planthopper [*Nilaparvatha lugens* (Stal)] (BPH) and white backed planthopper [*Sogatella furcifera* (Hoverth)] (WBPH) are predominant in terai region of western Uttar Pradesh. Among the 20 serious insect pests of rice, brown planthopper (BPH) and white backed planthopper (WBPH) (Homoptera: Delphacidae), are considered to be most destructive insect pests in Asian countries (Park *et al.* 2008). Brown planthopper and white backed planthopper may cause huge crop loss of 10-70% (Kulshreshtha 1974) and 35-95% (Sindhu 1979), respectively. The plant hoppers suck the plant sap from the phloem vessels through their proboscis. Due to this, plant starts wilting with outer most leaves drying first and then the entire plant dries up - a symptom often called hopper burn (Patcharin 2011). To date, it is well known that pest has developed high resistance to a variety of chemical insecticides including neonicotinoids compounds (Liu *et al.* 2003). Increases outbreaks and resistance problems in BPH and WBPH has become serious threat in rice production (Wang and Wang 2007, Balakrishna and Satyanarayana 2013). These problems therefore urge to search for alternatives novel chemicals which are effective and safe to the environment, in this regards present study has been carried to evaluate different novel insecticides against planthoppers. Presently, chemical control is the only practical method for a farmer to respond to an increasing plant hoppers infestation. Keeping these in view the present study was undertaken to test the relative efficacy of some novel insecticides against planthoppers.

MATERIALS AND METHODS

The experiment was conducted at research farm of Krishi Vigyan Kendra, Pilibhit during *kharif* 2017-18 and 2018-19 for two consecutive years. The experiment was laid in randomized block design (RBD), having 10 treatments including untreated control and were replicated thrice. The plot size was 4 × 3 m with spacing of 20 × 15 cm. Crop was raised with recommended package of practices except planthoppers protection measures. The test products acephate 50 + imidacloprid 1.8 SP @ 1 kg/ ha, ethiprole + imidacloprid 80 WG @ 125 g/ha., pymetrozine 50 WG @ 300 g/ha., imidacloprid 70 WG @ 75 g/ha., triflumezopyrim

[1]G L Bajaj Institute of Technology & Management, Greater Noida,Gautam Budh Nagar, UP (Email- chssdhaka@gmail.com); [2]KVK, Gautam Budh Nagar; UP. 3KVK, Ghaziabad, UP.

10 SC @ 235 ml/ha., thiamethoxam 25 WDG @ 200 g/ ha., dinotefuran 20 SG @ 200 g/ha., buprofezin 25 SC @ 1.0 l/ha and acephate 75 SP @ 1.0 kg/ha were tested for their bio-efficacy and there were untreated control plots against paddy planthoppers. All these insecticides were applied with knapsack sprayer and sprayed twice during cropping period. First spray was done at 50 days after sowing (based on ETL) and second sprays at 20 days after first spray.Observations on numbers of BPH and WBPH were recorded on 10 randomly selected hills per plot one day before spray (DBS), 5, 10, and 15 days after each spray and further these data were presented as average number of insects per hill. The details of treatments for management of insect pests under DDSR system are mentioned in Table 1. The data on number of hoppers per hill was subjected to the square root transformation and grain yield recorded at harvest was converted to quintal per ha prior to statistical analysis. The data was collected for both the years in the same way and finally data of both the years was pooled to make up the final data to be presented in tables. The data was analyzed by following the statistical procedure given by Panse and Sukhatme (1985).

RESULTS AND DISCUSSION

The results on the bio-efficacy of novel insecticide molecules against planthopper conducted during *kharif* 2017-18 and 2018-19 are presented here under.

Bioefficacy against brown planthopper

Prior to imposition of treatments population of BPH was uniform throughout the experiment and varied between 6.92 to 9.04 hoppers per hill. Hence it showed non-significant difference among the treatments (Table 1). However, variation among the population was noticed at five day after imposition of first application of insecticides. Treatment triflumezopyrim10 SC @ 235 ml/ ha recorded significantly lower number of BPH population (4.60 hoppers/hill) followed by pymetrozine 50 WG @ 300 g/ ha, dinotefuran 20 SG @ 200 g/ ha, ethiprole + imidacloprid 80 WG @ 125 g/ ha, buprofezin 25 SC @ 1 l/ha, acephate 50 + imidacloprid 1.8 SP @ 1 kg/ ha., thiamethoxam 25 WDG@ 200 g/ ha, imidacloprid70 WG @ 75 g/ ha and acephate 75 SP @ 1.0 kg/ ha (5.00, 5.07, 5.09, 5.21,5.34, 5.51, 5.58 and 8.11 hoppers/hill, respectively) but these treatments were at par with each other. However, the highest population of BPH was noticed in untreated control (9.46 hoppers/hill) (Table 1). Same trend was followed at 10 and 15 days after first spray. Similarly, the same trend was observed at 5, 10 and 15 days after second spray. The present findings of superior performance of the triflumezopyrim 10 SC @ 235 ml/ ha against brown planthopper was in accordance with reports of Ranjith Kumar *et al.* (2017) who opined that triflumezopyrim was found to be best treatment and was followed by dinotefuran. Similarly, Cardova *et al.* (2016) who also stated that triflumezopyrim is novel insecticides

Table 1 Response of insecticides on brown planthopper (BPH) population

Treatment	Dose	BPH/ hill							
		First spray				Second spray			
		1 DBS	5 DAS	10 DAS	15 DAS	1 DBS	5 DAS	10 DAS	15 DAS
Acephate 50 + imidacloprid 1.8 SP	1 kg/ha.	9.04 (3.16)	5.34 (2.52)	3.98 (2.23)	5.65 (2.58)	11.46 (3.53)	8.59 (3.10)	6.81 (2.79)	3.68 (2.16)
Ethiprole + imidacloprid 80 WG	125 g/ha.	8.45 (3.05)	5.09 (2.47)	3.76 (2.18)	5.29 (3.04)	10.92 (3.45)	8.05 (3.01)	6.27 (2.69)	3.14 (2.04)
Pymetrozine 50 WG	300 g/ha.	8.06 (2.99)	5.00 (2.45)	3.60 (2.14)	4.16 (2.98)	9.90 (3.30)	7.03 (2.83)	5.25 (2.49)	2.12 (1.76)
Imidacloprid 70 WG	75 g/ha.	6.92 (2.76)	5.58 (2.56)	5.03 (2.46)	6.09 (2.75)	12.88 (3.73)	10.00 (3.32)	8.22 (3.04)	5.10 (2.47)
Triflumezopyrim 10 SC	235 ml/ha.	8.55 (3.04)	4.60 (2.37)	2.89 (1.97)	3.56 (2.66)	9.66 (3.26)	6.79 (2.79)	5.01 (2.44)	1.88 (1.67)
Thiamethoxam 25 WDG	200 g/ha	8.18 (2.99)	5.51 (2.56)	4.55 (2.35)	5.71 (2.89)	12.32 (3.65)	9.44 (3.23)	7.66 (2.94)	4.54 (2.35)
Dinotefuran 20 SG	200 g/ha.	8.82 (3.11)	5.07 (2.46)	3.68 (2.16)	5.07 (2.65)	10.32 (3.36)	7.45 (2.91)	5.67 (2.58)	2.54 (1.87)
Buprofezin 25 SC	1.0 l/ha.	7.73 (2.94)	5.21 (2.49)	3.90 (2.21)	5.50 (3.19)	11.29 (3.50)	8.41 (3.07)	6.63 (2.76)	3.51 (2.12)
Acephate 75 SP	1.0 kg/ha.	7.97 (2.93)	8.11 (3.01)	7.51 (2.91)	8.92 (2.46)	13.83 (3.85)	10.96 (3.46)	9.18 (3.19)	6.05 (2.65)
Control		8.71 (3.11)	9.46 (3.23)	12.18 (3.63)	12.18 (2.99)	18.84 (4.45)	20.46 (4.63)	22.06 (4.80)	24.25 (5.02)
SEm (±)		0.129	0.067	0.094	0.690	0.071	0.067	0.079	0.110
CD (P=0.05)		N.S	0.143	0.199	0.187	0.214	0.201	0.235	0.329

Figure in parentheses are square root transformed values. DBS- Day before spray, DAS- Days after spray belonging to mesoionic group of insecticides and provides good control against brown planthopper. Pymetrozine was found next best treatment for the management of brown planthopper. Similar results on the efficacy of pymetrozine 50 WG against BPH and WBPH was earlier reported by Murali Bhaskaran *et al*. (2009a and b).

Bioefficacy against white backed planthopper

Population of white backed plant hopper, WBPH before the application of insecticides was found uniform throughout experiment and did not variy significantly among the treatments and ranged from 4.71 to 7.00 hoppers per hill. However, significant variation was noticed at five days after first spray. Significantly lower number (3.07 hoppers/hill) of hoppers was observed in the treatment triflumezopyrim 10 SC @ 235 ml/ha and it was on par with pymetrozine 50 WG @ 300 g/ha, dinotefuran 20 SG @ 200 g/ha and ethiprole + imidacloprid 80 WG @ 125 g/ha which recorded 3.46, 3.54 and 3.56 WBPH per hill, respectively. However, the highest WBPH population was noticed in untreated control (7.93 hoppers/hill) and it was significantly higher than buprofezin 25 SC @ 1.0 l/ha., acephate 50 + imidacloprid 1.8 SP @ 1 kg/ ha., thiamethoxam 25 WDG @ 200 g/ha, imidacloprid 70 WG @ 75/ g/ha and acephate 75 SP @ 1.0 kg/ ha (3.68, 3.81, 3.97, 4.05 and 5.89 hoppers /hill). Similar trend was observed at 10 and 15 days after first spray. Same trend was noticed at 5, 10 and 15 days after second spray also (Table 2).

The present findings are in line with Murali Bhaskaran *et al*. (2009b) who recorded 89.4 and 87.56% reduction in population of WBPH after application of pymetrozine 50 WG (Chess 50 WG) @ 400 and 350 g/acre, respectively. Similarly, Vasanta Bhanu (2015) also registered significantly less number of WBPH in pymetrozin 50 WG treatments and imidacloprid 17.8 SL was next best treatment. The results are also in close association with Guruprasad *et al*. (2016) who obtained the similar trend under transplanted field condition.

Yield and economics

All the treatments resulted in higher grain yield and proved significantly superior over untreated control (Table 3). The highest grain yield of 55.58 q/ha was harvested with triflumezopyrim 10 SC @ 235 ml/ ha while, pymetrozine 50 WG @ 300 g/ ha, dinotefuran 20SG @ 200 g/ ha, ethriprole + imidacloprid 80 WG @ 125 g/ ha, buprofezin25 SC @ 1.0 lit./ ha, acephate 50 + imidacloprid 1.8 SP @ 1 kg/ ha and acephate 75 SP @ 1.0 g/ ha were next best treatments with 53.79, 51.67, 50.79, 49.65, 48.69, 48.23, and 45.65 q/ ha. of grain yield, respectively. Highest C:B ratio of 2.08 was also observed in triflumezopyrim 10 SC @ 235 ml/ ha closely followed by pymetrozine 50 WG @ 300 g/ ha with

Table 2 Response of insecticides on white backed plant hopper (WBPH) population

Treatment	Dose	WBPH/ hill							
		First Spray				Second Spray			
		1 DBS	5 DAS	10 DAS	15 DAS	1 DBS	5 DAS	10 DAS	15 DAS
Acephate 50 + imidacloprid 1.8 SP	1 kg/ ha	7.00 (2.83)	3.81 (2.18)	2.61 (1.90)	4.13 (2.26)	8.40 (3.06)	5.72 (2.57)	4.46 (2.31)	2.86 (1.94)
Ethiprole + imidacloprid 80 WG	125 g/ha.	6.47 (2.73)	3.56 (2.13)	2.39 (1.84)	3.76 (2.17)	8.05 (3.01)	5.12 (2.45)	4.08 (2.24)	2.35 (1.81)
Pymetrozine 50 WG	300 g/ha.	6.23 (2.69)	3.46 (2.11)	2.23 (1.79)	2.64 (1.91)	7.28 (2.87)	4.52 (2.32)	3.28 (2.05)	1.26 (1.48)
Imidacloprid 70 WG	75 g/ha.	4.71 (2.39)	4.05 (2.24)	3.66 (2.16)	4.57 (2.36)	8.63 (3.06)	6.81 (2.76)	5.83 (2.59)	4.14 (2.26)
Triflumezopyrim 10 SC	235 ml/ha.	6.42 (2.72)	3.07 (2.02)	1.53 (1.59)	2.04 (1.74)	7.70 (2.95)	4.42 (2.28)	3.36 (2.06)	1.26 (1.50)
Thiamethoxam 25 WDG	200 g/ha	5.98 (2.62)	3.97 (2.23)	3.19 (2.04)	4.19 (2.27)	8.57 (3.07)	6.41 (2.69)	5.60 (2.56)	3.69 (2.16)
Dinotefuran 20 SG	200 g/ha.	6.90 (2.81)	3.54 (2.13)	2.31 (1.82)	3.55 (2.13)	7.38 (2.88)	5.11 (2.44)	4.09 (2.24)	2.42 (1.82)
Buprofezin 25 SC	1.0 l/ha.	5.88 (2.61)	3.68 (2.16)	2.53 (1.87)	3.98 (2.22)	7.20 (2.83)	5.39 (2.51)	4.54 (2.35)	2.62 (1.88)
Acephate 75 SP	1.0 kg/ha.	5.89 (2.61)	6.57 (2.75)	6.14 (2.67)	7.40 (2.89)	9.48 (3.21)	8.20 (3.03)	7.37 (2.89)	5.71 (2.56)
Control		6.62 (2.76)	7.93 (2.99)	10.82 (3.44)	10.66 (3.41)	12.76 (3.65)	15.09 (3.95)	18.07 (4.33)	18.40 (4.36)
SEm (±)		0.103	0.053	0.078	0.092	0.132	0.097	0.109	0.210
CD (P=0.05)		N.S	0.160	0.232	0.276	0.396	0.292	0.327	0.630

Figure in parentheses are square root transformed values. DBS- Day before spray, DAS- Days after spray

Table 3 Economics of various treatments in the management of BPH and WBPH

Treatment	Rate of chemical (₹/kg/unit)	Total cost of treatment/ application (₹/ha)	Yield (q/ha)	Yield obtained over control (q/ha)	Value of increased yield (₹/ha.)	Gross income (₹/ha.)	Net income (₹/ha.)	Cost: benefit ratio
Acephate 50 + imidacloprid 1.8 SP	800	5400.00	50.79	6.90	10350.00	76185.00	34805.00	1.84
Ethiprole + imidacloprid 80 WG	10000	2500.00	48.69	4.80	7200.00	73035.00	34555.00	1.90
Pymetrozine 50 WG	5000	3000.00	53.79	9.90	14850.00	80685.00	41705.00	2.07
Imidacloprid 70 WG	4000	600.00	46.23	2.34	3510.00	69345.00	32765.00	1.90
Triflumezopyrim 10 SC	1300	6500.00	55.58	11.69	17535.00	83370.00	40890.00	2.08
Thiamethoxam 25 WDG	1500	600.00	48.23	4.34	6510.00	72345.00	35765.00	1.98
Dinotefuran 20 SG	6600	1320.00	51.67	7.78	11670.00	77505.00	40205.00	1.96
Buprofezin 25 SC	1000	660.00	49.65	5.76	8640.00	74475.00	37835.00	2.03
Acephate 75 SP	900	800.00	45.65	1.76	2640.00	68475.00	31695.00	1.86
Control	-	-	43.89	-	-	-	-	-

Labour charges = ₹ 250/day; Rental value of sprayer = ₹ 40.00/day; Sale price of produce = ₹ 1500/q

C:B ratio of 2.07. The present findings are supported by that of Singh *et al*. (2018) who reported highest yield of 55.19 q/ha in the plots treated by pymetrozine 50 WG @ 400 g/ ha. Management of planthoppers through novel insecticides is practical and easily approachable to farming community. Among the various novel insecticides, triflumezopyrim 10 SC @ 235 ml/ ha, pymetrozine 50 WG @ 300 g/ ha and dinotefuran 20 SG @ 200 g/ ha were proved to be the most effective insecticides and these might be included in formulating IPM and/ or IRM strategies.

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