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BIOEFFICACY POTENTIAL OF TRIFLUMEZOPYRIM FOR THE MANAGEMENT OF RICE PLANTHOPPERS

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ABSTRACT
This is the first report on bioefficacy of triflumezopyrim 10.6 SC, an insecticide of mesoionic chemical class, against rice planthoppers, *Nilaparvata lugens* and *Sogatella furcifera* from the Punjab. Triflumezopyrim 10.6 SC was evaluated @ 5, 15, 25, 35, 50 and 100 g a.i. ha^{-1} and compared with the checks, imidacloprid 17.8 SL and buprofezin 25 SC @ 20 and 200 g a.i. ha^{-1}, respectively. Triflumezopyrim 10.6 SC @ 35 and 25 g a.i. ha^{-1} proved significantly superior to all other treatments at 3 days after spray (2.54 and 2.60 hoppers/hill, respectively), 7 DAS (1.98 and 1.99 hoppers/hill, respectively) and 14 DAS (2.43 and 2.48 hoppers/hill, respectively) in controlling the BPH population, however after 10 DAS, buprofezin 25 SC proved at par with triflumezopyrim 10.6 SC @ 25 g a.i. ha^{-1}, indicating the slow action of buprofezin. A similar trend, confirming superiority of triflumezopyrim 10.6 SC @ 35 and 25 g a.i. ha^{-1} over other treatments was recorded after 3 DAS (1.96 and 1.98 hoppers/hill, respectively) and 10 DAS (1.78 and 1.82 hoppers/hill, respectively) in controlling WBPH. The test insecticide was also found safe, without any observable phytotoxicity symptoms on rice. Thus, triflumezopyrim 10.6 SC @ 25 g a.i. ha^{-1} may be effectively used for the control of rice planthoppers.

INTRODUCTION

Rice (*Oryza sativa* L.) is the most significant food crop of developing world and is staple food for nearly half of the world's 7-plus billion people. Though more than 100 species of insect ract to lss than 200 words.pests have been reported on rice (Pathak and Khan, 1994) including five of national significance and twelve of regional importance (Prakash *et al.*, 2014), the brown planthopper, *Nilaparvata lugens* (Stal.) (BPH) and the whitebacked planthopper, *Sogatella furcifera* (Horvath) (WBPH) are the two most important sucking pests causing economic loss under north-Indian conditions. The nymphs as well as adults suck plant sap from phloem and occasionally from xylem. Enormous draining of sap results in drying of plants in circular patches called 'hopper-burn' and hence the yield loss.

Planthoppers are amenable to control with insecticides and hence farmers mostly rely on the use of insecticides for their control owing to their ease of application and immediate results. However, the widespread, indiscriminate and frequent use of insecticides has resulted in problems like insecticide resistance and resurgence (Krishnaiah *et al.,* 2006). Several insecticides have been reported effective against hoppers (Krishnaiah *et al.,* 2004; Wang *et al.,* 2008 and Suri *et al.,* 2012), but at the same time the reports on development of resistance (Nagata *et al.*, 1979; Krishnaiah *et al.,* 2006), resurgence (Krishnaiah *et al.,* 2006), elimination of natural predators and environmental pollution (Balakrishna and Satyanarayana, 2013) have also emerged following indiscriminate use insecticides on rice crop. Garrood *et al.* (2016) reported development of 220-fold resistance to imidacloprid and 223-fold to ethiprole in the rice brown planthopper populations collected from South and East Asia, whereas many strains showed high levels of resistance to both insecticides. In view of documented evidences on the development of resistance in BPH and WBPH against most extensively used group of insecticides, the neonicotinoids such as imidacloprid and burofezin (Gorman *et al.*, 2008; Wang *et al.,* 2008, Lakshmi *et al.*, 2010; Matsumura and Morimura, 2010; Ling *et al.*, 2011; Su *et al.*, 2013; Basanth *et al.*, 2013 and Garrood *et al.*, 2016), the evaluation of new insecticides must be a regular practice so as to search for safer and effective alternatives to minimize the planthoppers damage. Since, triflumezopyrim (DPX-RAB55 10.6 % w/v SC (10% w/w SC)) is a new insecticide molecule with unique mode of action (Cordova *et al.*, 2016) which is completely different to that neonicotinoids, it can be a potential alternative for planthoppers control in near future.

In the backdrop of above discussion, the new chemistry, triflumezopyrim was field evaluated with objectives of dose optimization against field population of rice planthoppers and assessing phytotoxicity of triflumezopyrim on rice.

MATERIALS AND METHODS

The field experiments were conducted at the Entomological

Research Farm, Punjab Agricultural University, Ludhiana, during *kharif* seasons of 2013 and 2014. The nursery of Pusa Basmati 1121 was sown in well prepared seed beds of 5 m x 1 m under unsprayed conditions following the recommended agronomic practices of PAU during both the years of investigation (Anon. 2013).

Thirty days old seedlings were transplanted in randomized block design with three replications. Two seedlings per hill were transplanted in a plot size of 50 m^2 with 1m replication border and 0.5 m treatment border between the plots, during the first fortnight of July during both the years. The plant to plant and row to row distance was maintained at 0.15 m and 0.20 m, respectively. The individual experimental plots were separated by bunds and water channels to ensure prevention of water movement from one plot to another. Urea was applied @ 0.100 t/ha in two equal splits i.e. 3 and 6 weeks after transplanting (Anon. 2013). Altogether, there were nine treatments including the untreated control and phytotoxicity treatments. These included triflumezopyrim 10.6 SC @ 5, 15, 25, 35, 50, 100 g ai/ha, besides insecticidal checks imidacloprid 17.8 SL @ 20 g ai/ha, buprofezin 25SC @ 200 g ai/ha, and the untreated control. Triflumezopyrim 10.6 SC @ 50 and 100 g ai/ha was evaluated for recording phytotoxicity only. Insecticides were applied once per season during both the years using 250-300 litres of water/ha. The population of BPH, WBPH and predatory spiders (*Lycosa* sp., and *Tetragnatha* sp) was recorded on 10 randomly selected hills per plot in each replication one day before treatment (BT) and 3, 7, 10, and 14 days after spray and presented as average number /hill following the standard methodology (Heinrichs *et al* 1981). Phytotoxicity data was recorded on a 0-100 per cent scale for yellowing, stunting, chlorosis, epinasty, hyponasty and necrosis where 0 meant 'no phytotoxicity' and 100 meant 'death of plant'. The data on mean number of planthoppers/hill were transformed using square root transformation. The treatment means were analysed through a randomized block design using Analysis of Variance (ANOVA) and were separated by least significant difference (LSD) at p=0.05 level (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Bioefficacy of triflumezopyrim 10.6 SC was tested under field conditions on the basis of number of planthoppers per hill, phytotoxicity effects using standard phytotoxicity rating scale, changes in spider population and finally the paddy yield.

Bioefficacy potential against BPH

Before insecticide application, the BPH population varied from 23.27 to 25.37 and 16.03 to 16.90 hoppers/ hill during 2013 and 2014, respectively (Table 1). The pre-treatment hopper population was uniformly distributed among different treatments, the differences amongst them being non-significant. Significant reduction in BPH population was recorded after 3-, 7-, 10- and 14 days of insecticide application in comparison to the untreated control. At 3 DAS, triflumezopyrim 10.6 SC @ 35 g a.i./ha recorded the lowest number of BPH (5.67 hoppers/ hill) followed by triflumezopyrim 10.6 SC @ 25 g a.i./ha (5.98 hoppers/hill), however, the two were statistically at par with each other but significantly superior to the checks, imidacloprid and buprofezin (7.95 and 11.65 hoppers/hill, respectively) and triflumezopyrim @ 5 and 15 g a.i./ha (12.97 and 10.02 hopper/hill, respectively). However, all the treatments proved better than the untreated control. Seven days after the application of insecticides, triflumezopyrim 10.6 SC @ 35 and 25 g a.i./ha (2.92 and 2.98 hoppers/hill, respectively) were found equally effective against BPH population. Among the two standard checks, buprofezin 25 SC @ 200 g a.i./ha (3.98 hoppers/hill) provided significantly better control of BPH than imidacloprid 17.8 SL @ 20 g a.i./ha (7.20 hoppers/hill), however, the two were significantly better than triflumezopyrim 10.6 SC @ 15 and 5 g a.i./ha (9.90 and 14.62 hopper/hill, respectively) and the untreated control (27.75 hopper/hill). A

Table 1: Bioefficacy of Triflumezopyrim 10.6 SC against brown planthopper infesting rice

Treatment	Dose		Mean number of brown planthopper per hill					
			BT			3 DAS		
	(g a.i./ ha)	(ml/ha)	2013	2014	Pooled	2013	2014	Pooled
Triflumezopyrim 10.6 SC	5	47.2	25.37(5.13)	16.63(4.19)	21.00(4.66)	16.20 (4.15)	9.73 (3.28)	12.97(3.71)
Triflumezopyrim 10.6 SC	15	141.5	23.37(4.94)	16.03(4.13)	19.70(4.53)	10.67 (3.42)	9.37 (3.22)	10.02(3.32)
Triflumezopyrim 10.6 SC	25	235.9	23.47(4.95)	16.87(4.23)	20.17(4.59)	8.33 (3.05)	3.63 (2.15)	5.98(2.60)
Triflumezopyrim 10.6 SC	35	330.2	25.03(5.10)	16.60(4.19)	20.82(4.65)	8.00 (3.00)	3.33 (2.08)	5.67(2.54)
Imidacloprid 17.8 SL	20	100	23.27(4.93)	16.80(4.22)	20.03(4.57)	9.43 (3.23)	6.47 (2.73)	7.95(2.98)
Buprofezin 25 SC	200	800	24.07(5.01)	16.90(4.23)	20.48(4.62)	15.33 (4.04)	7.97 (2.99)	11.65(3.52)
Untreated control	-	-	24.70(5.07)	16.73(4.21)	20.72(4.64)	30.33 (5.60)	20.07 (4.59)	25.20(5.09)
LSD (p=0.05)	-	-	(NS)	(NS)	(NS)	-0.19	-0.13	-0.11

Treatment	7 DAS			10 DAS			14 DAS		
	2013	2014	Pooled	2013	2014	Pooled	2013	2014	Pooled
Triflumezopyrim 10.6 SC	18.70 (4.44)	10.53 (3.40)	14.62(3.92)	19.40 (4.52)	10.74 (3.43)	15.07(3.97)	21.80 (4.78)	14.57 (3.94)	18.18(4.36)
Triflumezopyrim 10.6 SC	10.00 (3.32)	9.80 (3.29)	9.90(3.30)	14.03 (3.88)	10.27 (3.36)	12.15(3.62)	16.00 (4.12)	12.90 (3.73)	14.45(3.93)
Triflumezopyrim 10.6 SC	3.43 (2.10)	2.53 (1.88)	2.98(1.99)	5.33 (2.52)	3.10 (2.02)	4.22(2.27)	5.96 (2.64)	4.40 (2.32)	5.18(2.48)
Triflumezopyrim 10.6 SC	3.33 (2.08)	2.50 (1.87)	2.92(1.98)	5.00 (2.45)	3.03 (2.01)	4.02(2.23)	5.50 (2.55)	4.37 (2.32)	4.93(2.43)
Imidacloprid 17.8 SL	7.47 (2.91)	6.93 (2.81)	7.20(2.86)	9.10 (3.18)	9.67 (3.27)	9.38(3.22)	14.33 (3.92)	10.73 (3.43)	12.53(3.67)
Buprofezin 25 SC	4.87 (2.42)	3.10 (2.02)	3.98(2.22)	4.53 (2.35)	3.47 (2.11)	4.00(2.23)	6.27 (2.70)	5.53 (2.56)	5.90(2.63)
Untreated control	33.10 (5.84)	22.40 (4.84)	27.75(5.34)	35.00 (6.00)	24.90 (5.09)	29.95(5.54)	41.33 (6.51)	27.20 (5.31)	34.27(5.91)
LSD (p=0.05)	-0.12	-0.15	-0.09	-0.11	-0.16	-0.11	-0.1	-0.13	-0.07

Data values represent mean of 30 observations (10 hills/replication x 3 replications); *Figures in parentheses after sq. root transformations;** BT: Before treatment; DAS: Days after insecticide spray

Table 2: Bioefficacy of Triflumezopyrim 10.6 SC against whitebacked planthopper infesting rice

Treatment	Dose		Mean number of whitebacked planthopper per hill					
			BT			3 DAS		
	(g a.i./ ha)	(ml/ha)	2013	2014	Pooled	2013	2014	Pooled
Triflumezopyrim 10.6 SC	5	47.2	5.50(2.55)	4.33(2.31)	4.92(2.43)	5.20 (2.49)	3.93 (2.22)	4.57(2.36)
Triflumezopyrim 10.6 SC	15	141.5	5.77(2.60)	4.17(2.27)	4.97(2.44)	4.33 (2.31)	3.70 (2.17)	4.02(2.24)
Triflumezopyrim 10.6 SC	25	235.9	5.80(2.61)	4.70(2.38)	5.25(2.50)	3.10 (2.02)	2.77 (1.94)	2.93(1.98)
Triflumezopyrim 10.6 SC	35	330.2	6.00(2.65)	4.57(2.36)	5.28(2.50)	3.07 (2.02)	2.63 (1.90)	2.85(1.96)
Imidacloprid 17.8 SL	20	100	5.60(2.57)	4.67(2.38)	5.13(2.47)	4.70 (2.39)	3.83 (2.20)	4.27(2.29)
Buprofezin 25 SC	200	800	5.10(2.50)	4.30(2.30)	4.70(2.38)	4.03 (2.24)	3.90 (2.21)	3.97(2.23)
Untreated control	-	-	5.40(2.53)	4.43(2.33)	4.92(2.43)	6.17 (2.68)	5.23 (2.50)	5.70(2.59)
LSD (p=0.05)	-	-	(NS)	(NS)	(NS)	-0.11	-0.14	-0.08

Treatment	Mean number of whitebacked planthopper per hill								
	10 DAS			14 DAS			7 DAS		
	2013	2014	Pooled	2013	2014	Pooled	2013	2014	Pooled
Triflumezopyrim 10.6 SC	8.73 (3.12)	4.40 (2.32)	6.57(2.72)	9.10 (3.18)	7.10 (2.85)	8.10(3.01)	9.50 (3.24)	7.40 (2.90)	8.45(3.07)
Triflumezopyrim 10.6 SC	5.60 (2.57)	3.43 (2.10)	4.52(2.34)	6.07 (2.66)	5.23 (2.50)	5.65(2.58)	6.60 (2.76)	5.53 (2.56)	6.07(2.66)
Triflumezopyrim 10.6 SC	3.13 (2.03)	2.10 (1.76)	2.62(1.90)	2.83 (1.96)	1.83 (1.68)	2.33(1.82)	3.40 (2.10)	2.63 (1.90)	3.02(2.00)
Triflumezopyrim 10.6 SC	3.00 (1.99)	2.07 (1.75)	2.53(1.87)	2.63 (1.91)	1.77 (1.66)	2.20(1.78)	3.20 (2.05)	2.67 (1.91)	2.93(1.98)
Imidacloprid 17.8 SL	3.50 (2.12)	3.77 (2.18)	3.63(2.15)	4.00 (2.24)	4.17 (2.27)	4.08(2.25)	4.50 (2.35)	4.67 (2.38)	4.58(2.36)
Buprofezin 25 SC	3.10 (2.03)	2.33 (1.82)	2.72(1.92)	2.80 (1.95)	2.23 (1.80)	2.52(1.87)	3.60 (2.15)	2.83 (1.96)	3.22(2.05)
Untreated control	8.83 (3.14)	7.83 (2.97)	8.33(3.05)	10.33 (3.37)	8.87 (3.14)	9.60(3.25)	11.17 (3.49)	9.50 (3.24)	10.33(3.36)
LSD (p=0.05)	-0.08	-0.16	-0.09	-0.11	-0.09	-0.07	-0.08	-0.17	-0.09

Data values represent mean of 30 observations (10 hills/replication x 3 replications) ; *Figures in parentheses after sq. root transformations; ** BT: Before treatment; DAS: Days after spray of insecticide

Table 3: Impact of Triflumezopyrim 10.6 SC on natural enemies population in rice

Treatment	Dose		Mean number of spiders per hill										Yield (q/ha)	
			BT		3 DAS		7 DAS		10 DAS		14 DAS			
	(g a.i./ ha)	(ml/ha)	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014
Triflumezopyrim 10.6 SC	5	47.2	0.83	0.63	0.80	0.63	0.83	0.63	0.87	0.70	0.87	0.77	31.33	32.00
Triflumezopyrim 10.6 SC	15	141.5	0.83	0.63	0.80	0.67	0.87	0.70	0.93	0.73	0.93	0.70	33.00	33.70
Triflumezopyrim 10.6 SC	25	235.9	0.77	0.67	0.77	0.63	0.83	0.67	0.87	0.70	0.90	0.73	35.67	36.53
Triflumezopyrim 10.6 SC	35	330.2	0.80	0.63	0.77	0.60	0.83	0.67	0.87	0.73	0.87	0.77	36.33	36.60
Imidacloprid 17.8 SL	20	100.0	0.83	0.60	0.73	0.53	0.77	0.63	0.73	0.70	0.83	0.73	33.67	33.83
Buprofezin 25 SC	200	800.0	0.87	0.63	0.83	0.63	0.83	0.70	0.90	0.77	0.93	0.73	35.00	35.13
Untreated control	-	-	0.87	0.60	0.87	0.63	0.90	0.70	0.93	0.77	0.93	0.77	29.33	31.23
LSD (p=0.05)	-	-	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	2.43	1.73

Data values represent mean of 30 observations (10 hills/replication x 3 replications); * BT: Before treatment; DAS: Days after spray of insecticide

similar trend was observed at 10 DAS, however, buprofezin 25 SC @ 200 g a.i./ha (4.00 hoppers/hill) was found as equally effective as triflumezopyrim 10.6 SC @ 35 and 25 g a.i./ha (4.02 and 4.22 hoppers/hill, respectively) indicating that buprofezin acts slowly against hoppers. Asai *et al*. (1983) and Ghosh *et al*. (2013) also reported the slow action of buprofezin in controlling the BPH. Two week after spray, triflumezopyrim 10.6 SC @ 35 and 25 g a.i./ha (4.93 and 5.18 hoppers/hill, respectively) were better in suppressing BPH, followed by buprofezin (5.90 hoppers/hill) and imidacloprid (12.53 hoppers/hill). Triflumezopyrim 10.6 SC @ 35 and 25 g a.i./ha was equally effective against BPH, and therefore, the lower dose of 25 g a.i./ha may be considered ideal for effective control of BPH.

The present results are in confirmation with the work of Holyoke *et al* (2015) who reported triflumezopyrim as an extremely effective insecticide with a unique mode of action against the planthoppers. Gurulingappa *et al*. (2016) also studied the efficacy of triflumezopyrim 10.6 SC for controlling the field populations of rice planthoppers and reported it as a highly effective molecule against the BPH and the WBPH. These workers also emphasized that triflumezopyrim provided long lasting control of planthoppers which helps in reducing the frequency of chemical sparays in the field. The present results are also in line with wok of Singh *et al*. (2016) who reported triflumezopyrim as an effective and safe alternative to keep a check on the population of rice planthoppers. Similarly, Baehaki *et al*. (2016) reported triflumezopyrim to be a highly effective molecule for suppressing BPH in rice in East Java.

Bioefficacy potential against WBPH

The pre-treatment WBPH population varied from 5.10 to 6.00 and 4.17 to 4.70 hoppers/ hill over the treatments, during 2013 and 2014, respectively (Table 2). Pooled analysis clearly revealed that the pre-treatment hopper population was uniformly distributed among the various treatments with non-significant differences amongst all; however, a significant population reduction was recorded after 3-, 7-, 10- and 14 days of insecticide application. At 3 DAS, triflumezopyrim 10.6 SC @ 35 g a.i./ha recorded the lowest number of WBPH per hill (2.85 hoppers/hill) followed by triflumezopyrim 10.6 SC @ 25 g a.i./ha (2.93 hoppers/hill), the two being statistically at par with each other but significantly superior to all other treatments in controlling the WBPH. Buprofezin 25 SC @ 200 g a.i./ha (3.97 hoppers/hill) showed numerically better control than triflumezopyrim 10.6 SC @ 15 g a.i./ha (4.02 hoppers/ hill) and imidacloprid 17.8 SL @ 20 g a.i./ha (4.27 hoppers/ hill), however, the three were statistically at par with each other. After 7 days of insecticide application, triflumezopyrim 10.6 SC @ 35 g & 25 g a.i./ha, and buprofezin 25 SC @ 200 g a.i./ha with 2.53, 2.62 and 2.72 hopper/hill, respectively were statistically at par in suppressing WBPH population. Imidacloprid @ 20 g a.i./ha (3.63 hoppers/hill) proved inferior to triflumezopyrim 10.6 SC @ 35 and 25 g a.i./ha, and buprofezin 25 SC @ 200 g a.i./ha, but superior to the lower doses of triflumezopyrim (5 g and 15 g a.i./ha) and the untreated control. A similar trend was recorded at 10- and 14 DAS, wherein the triflumezopyrim @ 35 and 25 g a.i./ha and buprofezin @ 200 g a.i./ha were found significantly better in controlling the field population of WBPH than all the other treatments. As observed in the case of BPH, both the higher test doses of triflumezopyrim 10.6 SC (35 and 25 g a.i./ha) proved at par in suppressing WBPH. Thus the lower dose of triflumezopyrim (25 g a.i./ha) may be considered ideal for managing WBPH. The present results on field efficacy of triflumezopyrim against WBPH corroborate the findings of Holyoke *et al*. (2015), Gurulingappa *et al*. (2016) and Singh *et al*. (2016) who reported triflumezopyrim as a highly effective molecule for controlling the whitebacked planthopper in rice.

During both the years of investigation, imidacloprid 17.8 SL @ 20 g a.i./ha, the most extensively used neonicotinoid as a first line of defence against rice planthoppers proved inferior to triflumezopyrim 10.6 SC @ 35 and 25 g a.i./ha and buprofezin 25 SC @ 200 g a.i./ha in controlling BPH and WBPH. These results corroborate the findings of Ghosh *et al*. (2013) who also reported the lower efficacy of imidacloprid against rice BPH and WBPH among the traditionally used neonicotinoids.

Impact on natural enemies

The population of natural enemies was moderate during both the years. Perusal of table 3 reveals that the spider population before application of insecticides ranged from 0.77 to 0.87/ hill during 2013, and 0.60 to 0.67/hill during 2014, the differences among the treatments being non-significant. The data also indicated that at all the observation dates, the number of spiders in triflumezopyrim 10.6 SC treatments and the standard checks were statistically at par with the respective control which is indicative of safety of triflumezopyrim towards natural enemies of rice agroecosystem. Holyoke *et al*. (2015) also reported triflumezopyrim to be safer on non-target organisms including pollinators. Rattan *et al*. (2016) also reported triflumezopyrim 10.6 SC as harmless (IOBCC at 1, $<$30% mortality) to different species of predators and parasitoids under field conditions in addition to spiders tested under laboratory conditions. The present results of safety of buprofezin to spiders are also in confirmation with the earlier reports of Heinrichs *et al*. (1984), Krishnaiah *et al*. (1996) and Hedge and Nidagundi (2009) who reported buprofezin to exhibit a good degree of safety towards the spider population.

Marketable yield

During 2013, highest paddy yield was recorded in plots treated with triflumezopyrim 10.6 SC @ 35 g a.i/ha (36.33 q/ha) which was statistically at par with those treated with triflumezopyrim 10.6 SC @ 25 g a.i/ha (35.67 q/ha) and buprofezin (35.00 q/ ha) whereas, the untreated control recorded the lowest yield of 29.3 q/ha (Table 3). Similarly, during 2014 the highest yield was observed in triflumezopyrim 10.6 SC @ 35 g a.i/ha (36.60 q/ha) which was statistically at par with that of triflumezopyrim 10.6 SC @ 25 g a.i/ha (36.53 q/ha) and buprofezin (35.13 q/ ha) whereas, the untreated control recorded the lowest yield (31.2 q/ha). The present results of obtaining the highest paddy yield in triflumezopyrim 10.6 SC @ 35 and 25 g a.i/ha corroborate the earlier findings of Gurulingappa *et al*. (2016), who reported higher number of productive tillers in triflumezopyrim treatment in contrast to the control.

Insecticidal phytotoxicity

No phytotoxicity was observed in any of the triflumezopyrim 10.6 SC treatments and the tested dosages *viz*., 5, 15, 25, 35, 50 and 100 g a.i./ha were found safe to the rice.

The present study is a part of our continuous efforts to search for new safer and effective insecticides against rice planthoppers. Available data on triflumezopyrim efficacy against rice planthoppers and safety to natural enemies is scanty as this product is new. However, it is evident from the present investigations that triflumezopyrim 10.6 SC @ 25 g a.i/ha provides outstanding control of the rice planthoppers. Further, attributes including safety towards spiders and distinct mode of action from neonictinoids render it a potential tool for solving problem of insecticidal resistance in planthoppers against most extensively used neonicotinoids in Asia.

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