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Relative Toxicity of New insecticide Molecules against Rice Leaf Folder and Brown Plant Hopper and their effect on Natural Enemies

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ABSTRACT: In the recent years, new selective insecticides non-toxic to natural enemies has enhanced the pest management efficiency and safe guarding the crop ecosystem. Moreover, pesticides with single active principle are likely to induce the development of resistance in insects. The present experiment on the newer molecules were conducted during *kharif* 2019 and *rabi* 2020 to assess the relative toxicity of triflumezopyrim 10% + spinetoram 12% WDG (22%) WDG against rice leaf folder and brown plant hopper and their study on safety to natural enemies. The experiment was comprising of seven treatments *viz.*, T_1: Triflumezopyrim 10% + spinetoram 12% (22%) WDG@ 44 g ai ha^{-1}; T_2: Triflumezopyrim 10% + spinetoram 12% (22%) WDG @ 55 g ai ha^{-1}; T_3: Triflumezopyrim 10% + spinetoram 12% (22%) WDG @ 66 g ai ha^{-1}; T_4: Triflumezopyrim 10.6% SC@ 25 g ai ha^{-1}; T_5: Spinetoram 12% SC @ 30 g ai ha^{-1}; T_6: Fipronil 5% SC @ 75 g ai ha^{-1}; T_7: Untreated Control. The lowest BPH population was recorded in triflumezopyrim 10% + spinetoram 12% (22%) WDG @ 66 g aiha^{-1} which are statistically at par with triflumezopyrim 10% + spinetoram 12% (22%) WDG @ 55 g aiha^{-1} throughout the observation. Similarly, lowest leaf folder damaged leaf (LFDL) was recorded in triflumezopyrim 10% + spinetoram 12% (22%) WDG @ 66 g aiha^{-1}. Triflumezopyram 10% + spinetoram 12% (22%) WDG @ 55 g aiha^{-1} provided effective control of leaf folder and brown plant hopper. Further, triflumezopyrim 10% + spinetoram 12% (22%) WDG@ 55 g aiha^{-1} was found to be safe to the predatory mirid bug, *Cyrtorhinus lividipennis* and wolf spider, *Pardosa pseudoannulata* in rice ecosystem.

Keywords: Toxicity, triflumezopyrim, spinetoram, leaf folder, brown plant hopper, natural enemies, rice

INTRODUCTION

Rice is grown in warm and humid environments in South and South East Asia which is conducive for the survival and proliferation of insect pests like yellow stem borer (*Scirpophaga incertulas*), leaf folder (*Cnaphalocrocis medinalis*), brown plant hopper (*Nilaparvata lugens*), white backed plant hopper (*Sogatella furcifera*), swarming caterpillar (*Spodoptera mauritia*), gundhi bug (*Leptocorisa* sp.) and green leaf hopper (*Nephotettix* sp.) (Savary *et al.,* 2000; Mohapatra *et al.,* 2014). Among them, rice leaffolder larvae fold the leaves by stitching the leaf margins and feed inside the leaf roll by scraping green leaf tissue. In the leaf folder epidemic scenario, the yield loss ranges from 30 to 80 per cent (Tanwar *et al.,* 2019). In addition, brown plant hopper sucks the cell sap from the rice plant causing the plant to dry out, turn brown and die. This condition is called hopperburn and it can cover large patches in rice fields. In recent years, the brown plant hopper has developed resistance to almost all class of insecticides used for control. Among the various strategies adopted to manage these notorious pests, insecticides are the first line of defense. Introduction of new selective insecticides non-toxic to natural enemies has improved the management of rice insect pests. Moreover, pesticides with single active principle are likely to induce the development of resistance in insects. Triflumezopyrim (TFM), the recently developed insecticide is a new class of insecticide categorized as mesoionics reported by Cordova *et al.* (2016); Baehaki *et al.* (2017) whereas spinetoram is an insecticidal mixture of two active neurotoxic constituents of *Saccharopolyspora spinosa*. Combination of triflumezopyrim 10% + spinetoram 12% with different mode of action are unlikely lead to pesticide resistance. In this view, the present study was undertaken to determine the effective field dose of triflumezopyrim 10% + spinetoram 12% against brown plant hopper and leaf folder in rice.

MATERIAL AND METHODS

The present experiment was conducted at research farm of ICAR-National Rice Research Institute, Cuttack

during *kharif* 2019 and *rabi* 2020 (20°N and 86°E with 24m above MSL) to study the relative toxicity of triflumezopyrim 10% + spinetoram 12% (22%) WDG against rice leaf folder (RLF) and brown plant hopper (BPH). Rice cultivar TN 1 was used in the experiment because of susceptibility to target insects. The three weeks old seedlings were transplanted in plot size of 4.5 × 5 m^2 with a spacing of 20 × 15 cm. Recommended package of practices with fertilizer dose of 60:30:30 for raising good crop in the nursery and main field were followed. Nitrogenous fertilizer was applied in three split doses. Crop management as per standard practice including the control of non-target insect pests and diseases though foliar sprays of pesticides were adopted. After pre-treatment count, when the insect pest population reached above economic threshold level (ETL), the spray solutions of different doses of insecticides were prepared as per treatment schedule (Table 1). The spraying was undertaken in the morning hours through battery operated knapsack sprayer. The quantity of water taken as 500 liters per hectare. After 15 days of first spray, the second spray was undertaken.

Table 1: Treatment details.

Sr. No.	Treatments	Dose (g aiha^{-1})	Product g or ml ha^{-1}	Product g or ml plot^{-1}
1.	Triflumezopyrim 10% + Spinetoram 12% (22%)WDG	44 (20+24)	200	0.45
2.	Triflumezopyrim 10% + Spinetoram 12% (22%)WDG	55 (25+30)	250	0.56
3.	Triflumezopyrim 10% + Spinetoram 12% (22%)WDG	66 (30+36)	300	0.68
4.	Triflumezopyrim 10.6% SC	25	235.8	0.53
5.	Spinetoram 12% SC	30	250	0.57
6.	Fipronil 5%SC	75	1500	3.38
7.	Untreated Control	-	-	-

Observation (i) *Brown plant hopper:* At random 20 hills per plot selected and number of BPH per hill were counted at 0, 3, 7, 10 and 14 days after imposition of treatments

(ii) *Leaf folder:* Similarly, randomly 20 hills plot^{-1} were select and counted number of leaf folder damaged leaves per hill and estimation of damage was done on a rating scale of 1-5 (Table 2) at 0, 3, 7, 10 and 14 days after insecticide application.

Table 2: Damage scale due to rice leaf folder.

Scale	Parameter
1	No damage/scrapping on leaveshill^{-1}
2	10-30% damage on leaveshill^{-1}
3	30-50% damage on leaveshill^{-1}
4	50-80% damage on leaveshill^{-1}
5	>80% damage on leaveshill^{-1}

(iii) *Yield*: Rice grain yield of each treatment was also recorded and the same was converted to yield ha^{-1}.

(iv) *Natural enemies:* The numbers of natural enemies like mirid bug, *Cyrtorhinus lividipennis* and wolf spider, *Pardosa pseudoannulata* on 20 randomly selected hills were recorded at each observation date and presented as average number hill.

Data recorded on pest and natural enemies' population and grain yields from the experiment were transformed and analyzed to draw a meaningful conclusion as suggested by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

The combination of new insecticide molecules was tested under field condition on the basis of number of hoppers per hill, no of leaf folder damaged leaves per hill, changes in the population of natural enemies and finally the yield. All the treatments gave a significantly superior control of the target pest over the untreated control at 3,7,10 and 14 days after pesticide spraying. The treatment, triflumezopyrim 10% + spinetoram 12% (22%) WDG @ 66 g ai ha^{-1} was significantly superior over other treatments throughout the observation period.

Brown plant hopper: It is evident from the results (Table 3 and 4) that the hopper population had reached the economic threshold level (ETL) before the application of insecticides and the population did not vary significantly among the plots earmarked for treatment imposition. At 3 days after first spraying, the triflumezopyrim 10% + spinetoram 12% (22%) WDG @ 66 g ai ha^{-1} recorded lowest number (0.9 and 1.4 BPH hill^{-1}) followed by triflumezopyrim 10% + spinetoram 12% (22%) WDG @ 55 g ai ha^{-1} (1.2 and 2.1 BPH hill^{-1}) during both the seasons. However, the BPH population between these two treatments didn't differ significantly. Upto 15 days after first spray, triflumezopyrim 10% + spinetoram 12% (22%) WDG @ 55 and 66 g ai ha^{-1} maintained the population of BPH below economic threshold level (ETL). Same trend was noticed after 2nd spray also. Population of hoppers considerably reduced after 3 days of spraying and continued even after 7 days. Lowest BPH population (0.9 and 1.4 BPH hill^{-1}) was recorded in triflumezopyrim 10% + spinetoram 12% (22%) WDG @ 66 g ai ha^{-1} which are statistically at par with 55g ai ha^{-1} (1.0 and 2.3 BPH hill^{-1}) 14 days after second spray in both the seasons. Triflumezopyrim 10% +

spinetoram 12% (22%) WDG @ 55 g ai/ha were recorded as the best treatments over other doses of triflumezopyrim 10% + spinetoram 12% (22%) WDG *i.e*., 44 g aiha^{-1} and triflumezopyrim 10.6% SC, spinetoram 12% SC and fipronil 5% SC. Present results on higher efficacy of triflumezopyrim10% + spinetoram 12% (22% WDG) against BPH can be corroborated with the findings of Guruprasad *et al.* (2016) who reported that triflumezopyrim @ 25 and35 g aiha^{-1} found to be effective in reducing the brown planthopper population. The present findings are also in agreement with the previous reports of novel chemical molecules cyzypyr by Venkatreddy *et al.* (2012) in suppressing the planthopper population. **Rice Leaf Folder.** The results depicted in Table 5 and 6 on damage rating by leaf folder in rice revealed that the infestation level was above economic threshold level (ETL) in mid tillering stage in untreated control which was significantly higher than all the treatments in both the seasons. However, triflumezopyrim 10% + spinetoram 12% (22%) WDG @ 55 g aiha^{-1} and triflumezopyrim 10% + spinetoram 12% (22%) WDG @ 66 g ai ha^{-1}% LFDL recorded mean leaf folder damage score of 1.02, 0.99 and 1.0 and 1.0 after 3 days of first spraying in mid tillering stage of rice crop in both the season, respectively. In terms of leaf folder damage score, triflumezopyrim 10% + spinetoram 12% (22%) WDG @ 66 g aiha^{-1} were recorded as the best treatment over other doses of triflumezopyrim 10% +spinetoram 12% (22%) WDG @55g aiha^{-1}, triflumezopyrim 10% + spinetoram 12% (22%) WDG @44 g aiha^{-1} and triflumezopyrim 10.6% SC, spinetoram 12% SC and fipronil 5% SC.

Table 3: Efficacy of triflumezopyrim 10% + spinetoram 12% WDG against brown planthopper in paddy during *kharif 2019.*

Tr. No.	Treatments	Dose (g ai ha^{-1})	Formulation(g or mlha^{-1})	BPHhill^{-1}								
				DBT	1st Spray				2nd Spray			
					3DAT	7DAT	10DAT	14DAT	3DAT	7DAT	10DAT	14DAT
T_1	Triflumezopyrim 10% + Spinetoram 12% (22%)WDG	44 (20+24)	200	11.5 (3.46)	4.1 (2.14)	1.7 (1.48)	2.1 (1.61)	2.5 (1.73)	3.5 (2.00)	1.0 (1.22)	1.8 (1.52)	2.2 (1.64)
T_2	Triflumezopyrim 10% + Spinetoram 12% (22%)WDG	55 (25+30)	250	10.7 (3.35)	1.2 (1.30)	0.6 (1.05)	0.5 (1.00)	1.2 (1.30)	1.5 (1.41)	0.4 (0.95)	0.7 (1.10)	1.0 (1.22)
T_3	Triflumezopyrim 10% + Spinetoram 12% (22%)WDG	66 (30+36)	300	10.2 (3.27)	0.9 (1.18)	0.4 (0.95)	0.3 (0.89)	0.8 (1.14)	1.0 (1.22)	0.2 (0.84)	0.5 (1.00)	0.9 (1.18)
T_4	Triflumezopyrim 10.6% SC	25	235.8	10.5 (3.32)	3.2 (1.92)	1.3 (1.34)	1.3 (1.34)	1.9 (1.55)	3.1 (1.90)	0.8 (1.14)	1.1 (1.26)	1.7 (1.48)
T_5	Spinetoram 12% SC	30	250	11.3 (3.44)	5.6 (2.47)	4.2 (2.17)	3.4 (1.97)	4.0 (2.12)	4.8 (2.30)	4.2 (2.17)	3.3 (1.95)	3.9 (2.10)
T_6	Fipronil 5%SC	75	1500	10.8 (3.36)	7.5 (2.83)	6.0 (2.55)	6.5 (2.65)	7.3 (2.79)	6.7 (2.68)	4.6 (2.26)	5.3 (2.41)	5.7 (2.49)
T_7	Untreated Control	-	-	10.6 (3.33)	11.3 (3.44)	13.1 (3.69)	14.7 (3.90)	15.8 (4.04)	9.3 (3.13)	11.3 (3.44)	12.6 (3.62)	13.1 (3.69)
	CD @ 5%			**NS**	**0.375**	**0.462**	**0.478**	**0.435**	**0.405**	**0.448**	**0.476**	**0.455**

Data in parentheses are√(x+0.5) transformed values; , NS-Non significant; DBT: Days before treatment; DAT: Days after Treatment

Table 4: Efficacy of Triflumezopyrim 10% + spinetoram 12% WDG against brown planthopper in paddy during *rabi 2020.*

Tr. No.	Treatments	Dose (g ai ha^{-1})	Formulation(g or ml ha^{-1})	BPHhill^{-1}								
				DBT	1st Spray				2nd Spray			
					3DAT	7DAT	10DAT	14DAT	3DAT	7DAT	10DAT	14DAT
T_1	Triflumezopyrim 10% + Spinetoram 12% (22%)WDG	44 (20+24)	200	20.1 (4.54)	3.8 (2.07)	3.5 (1.99)	5.5 (2.45)	7.2 (2.78)	3.2 (1.93)	2.9 (1.85)	4.1 (2.14)	4.4 (2.22)
T_2	Triflumezopyrim 10% + Spinetoram 12% (22%)WDG	55 (25+30)	250	20.4 (4.57)	2.1 (1.60)	0.8 (1.12)	1.4 (1.38)	3.5 (1.99)	1.7 (1.49)	0.7 (1.07)	1.2 (1.30)	2.3 (2.3)
T_3	Triflumezopyrim 10% + Spinetoram 12% (22%)WDG	66 (30+36)	300	20.7 (4.61)	1.4 (1.38)	0.4 (0.96)	1.0 (1.21)	2.7 (1.79)	1.2 (1.30)	0.3 (0.91)	0.9 (1.17)	1.4 (1.38)
T_4	Triflumezopyrim 10.6% SC	25	235.8	20.1 (4.54)	3.5 (1.99)	2.1 (1.60)	3.0 (1.88)	4.1 (2.14)	2.9 (1.85)	1.7 (1.49)	2.6 (1.76)	2.9 (1.85)
T_5	Spinetoram 12% SC	30	250	19.9 (4.51)	5.8 (2.52)	3.5 (1.99)	5.0 (2.34)	5.9 (2.54)	5.0 (2.34)	2.9 (1.85)	4.2 (2.17)	4.9 (2.32)
T_6	Fipronil 5%SC	75	1500	20.2 (4.53)	7.7 (2.86)	4.5 (2.24)	6.1 (2.56)	6.8 (2.70)	4.8 (2.29)	3.8 (2.07)	4.6 (2.27)	5.2 (2.38)
T_7	Untreated Control	-	-	20.0 (4.53)	22.9 (4.84)	25.5 (5.10)	26.8 (5.22)	29.4 (5.47)	26.1 (5.16)	20.2 (4.55)	16.7 (4.15)	14.3 (3.84)
	CD @ 5%			**NS**	**0.384**	**0.455**	**0.503**	**0.360**	**0.398**	**0.480**	**0.473**	**0.514**

Data in parentheses are√(x+0.5) transformed values; NS-Non significant; DBT: Days before treatment; DAT: Days after Treatment

Table 5: Efficacy of triflumezopyrim 10% + spinetoram 12% WDG against leaf folder in paddy during *kharif* 2019.

Tr. No.	Treatments	Dose (g ai ha^{-1})	Formulation (g or ml ha^{-1})	Leaf folder (Damage Score)								
				1st Spray					2nd Spray			
				DBT	3DAT	7DAT	10DAT	14DAT	3DAT	7DAT	10DAT	14DAT
T_1	Triflumezopyrim 10% + Spinetoram 12% (22%)WDG	44 (20+24)	200	1.24	1.00	1.13	1.40	1.50	1.13	1.20	1.15	1.06
T_2	Triflumezopyrim 10% + Spinetoram 12% (22%)WDG	55 (25+30)	250	1.27	1.00	1.03	1.04	1.05	1.02	1.00	1.03	1.08
T_3	Triflumezopyrim 10% + Spinetoram 12% (22%)WDG	66 (30+36)	300	1.28	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.02
T_4	Triflumezopyrim 10.6% SC	25	235.8	1.20	1.10	1.24	1.20	1.50	1.10	1.26	1.03	1.06
T_5	Spinetoram 12% SC	30	250	1.25	1.20	1.31	1.53	1.49	1.16	1.30	1.18	1.11
T_6	Fipronil 5%SC	75	1500	1.30	1.55	1.78	2.01	2.07	1.64	1.53	1.30	1.23
T_7	Untreated Control	-	-	1.16	1.92	2.21	2.53	2.47	2.76	2.82	2.37	2.06
	CD @ 5%			**NS**	**0.045**	**0.053**	**0.062**	**0.058**	**0.063**	**0.055**	**0.058**	**0.062**

Table 6: Efficacy of triflumezopyrim 10% + spinetoram 12% WDG against leaf folder in paddy during *rabi* 2020.

Tr. No.	Treatments	Dose (g ai ha^{-1})	Formulation (g or ml ha^{-1})	Leaf folder (Damage Score)								
				1st Spray					2nd Spray			
				DBT	3DAT	7DAT	10DAT	14DAT	3DAT	7DAT	10DAT	14DAT
T_1	Triflumezopyrim 10% + Spinetoram 12% (22%)WDG	44 (20+24)	200	1.22	1.28	1.31	1.38	1.47	1.11	1.18	1.13	1.12
T_2	Triflumezopyrim 10% + Spinetoram 12% (22%)WDG	55 (25+30)	250	1.27	1.02	1.05	1.02	1.03	1.00	0.98	0.94	1.03
T_3	Triflumezopyrim 10% + Spinetoram 12% (22%)WDG	66 (30+36)	300	1.25	0.97	0.99	0.97	0.98	0.98	0.93	0.90	1.00
T_4	Triflumezopyrim 10.6% SC	25	235.8	1.18	1.08	1.22	1.18	1.47	1.08	1.23	1.01	1.04
T_5	Spinetoram 12% SC	30	250	1.23	1.18	1.28	1.50	1.46	1.14	1.27	1.16	1.09
T_6	Fipronil 5%SC	75	1500	1.27	1.52	1.74	1.97	2.03	1.61	1.50	1.27	1.21
T_7	Untreated Control	-	-	1.14	1.88	2.17	2.48	2.42	2.70	2.76	2.32	2.02
	CD @ 5%			**NS**	**0.065**	**0.063**	**0.052**	**0.058**	**0.063**	**0.043**	**0.055**	**0.047**

Table 7: Effect of Triflumezopyrim 10% + Spinetoram 12% WDG against Natural Enemy in paddy during *kharif* 2019.

Tr. No.	Treatment	Dose (g ai ha^{-1})	Formulation (g or ml ha^{-1})	Natural enemyhill^{-1}					
				DBT		*kharif 2019*			
						3 DAT		14 DAT	
				Mirid bug	Spider	Mirid bug	Spider	Mirid bug	Spider
T_1	Triflumezopyrim 10% + Spinetoram 12% (22%) WDG	44 (20+24)	200	2.2 (1.50)	4.5 (2.13)	1.8 (1.36)	2.5 (1.60)	2.1 (1.47)	3.5 (1.88)
T_2	Triflumezopyrim 10% + Spinetoram 12% (22%) WDG	55 (25+30)	250	2.6 (1.63)	3.8 (1.96)	1.5 (1.24)	2.2 (1.50)	1.8 (1.36)	3.4 (1.86)
T_3	Triflumezopyrim 10% + Spinetoram 12% (22%) WDG	66 (30+36)	300	2.1 (1.47)	4.0 (2.01)	1.3 (1.16)	1.6 (1.28)	1.5 (1.24)	3.0 (1.75)
T_4	Triflumezopyrim 10.6% SC	25	235.8	1.9 (1.40)	3.7 (1.94)	2.3 (1.53)	2.1 (1.47)	1.9 (1.40)	3.3 (1.83)
T_5	Spinetoram 12% SC	30	250	2.4 (1.57)	4.3 (2.09)	1.9 (1.40)	3.5 (1.88)	2.2 (1.50)	3.7 (1.94)
T_6	Fipronil 5% SC	75	1500	2.0 (1.43)	3.1 (1.77)	1.7 (1.32)	2.7 (1.66)	1.5 (1.24)	3.2 (1.80)
T_7	Untreated Control	-	-	2.2 (1.50)	3.7 (1.94)	2.5 (1.60)	3.8 (1.96)	2.9 (1.72)	4.3 (2.09)
	CD @ 5%			**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Data in parentheses are√(x+0.5) transformed values; , NS-Non significant; DBT: Days before treatment; DAT: Days after Treatment

However, there was no significant difference between triflumezopyrim 10% + spinetoram 12% (22%) WDG @66 g aiha^{-1} and triflumezopyrim 10% + spinetoram 12% (22%) WDG @55 g aiha^{-1}. The present results are also in conformity with the findings of Sarao *et al*. (2008); Kumar *et al.* (2010); Aulakh *et al.* (2016).

Natural Enemies. Population of natural enemies was found to be moderate in both seasons. Mirid bug and wolf spider were more abundant. Population of mirid bug was found to be highly dependent on the availability of brown plant hopper for preying. It is evident from the Table 7 and 8 that mean number of mirid bug per hill after 15 days of first insecticidal treatment was comparatively low in all insecticide treated plots than the untreated control. The predatory mirid bug population recorded at 3 and 14 days after insecticide application indicated no significant variation among the treatments.

Grain Yield. The two years pooled data of rice grain yield (Table 9) revealed that among all the treatments, triflumezopyrim 10%+ spinetoram 12% (22%) WDG @ 66 g aiha^{-1} recorded highest grain yield (4.3 tha^{-1}) and was on par with triflumezopyrim 10% + spinetoram 12% (22%) WDG @ 55 g aiha^{-1} (4.0 tha^{-1}) which is significantly superior over untreated control (3.0 tha^{-1}). Guruprasad *et al.* (2016) reported that triflumezopyrim @ 35 and 25 g ai ha^{-1} were superior over other treatments and control which registered significantly higher yield of 7.60 and 7.31 ha^{-1}, respectively.

Table 8: Effect of Triflumezopyrim 10% + Spinetoram 12% WDG against Natural Enemy in paddy during *rabi* 2020.

Tr. No.	Treatment	Dose (g ai ha^{-1})	Formulation (g or ml ha^{-1})	Natural enemies hill^{-1}					
				DBT		*rabi 2020*			
						3 DAT		14 DAT	
				Mirid bug	Spider	Mirid bug	Spider	Mirid bug	Spider
T_1	Triflumezopyrim 10% + Spinetoram 12% (22%) WDG	44 (20+24)	200	2.5 (1.60)	3.3 (1.83)	1.4 (1.20)	3.6 (1.91)	1.9 (1.40)	4.1 (2.04)
T_2	Triflumezopyrim 10% + Spinetoram 12% (22%) WDG	55 (25+30)	250	1.9 (1.40)	3.6 (1.91)	1.2 (1.12)	3.4 (1.86)	2.1 (1.47)	3.9 (1.99)
T_3	Triflumezopyrim 10% + Spinetoram 12% (22%) WDG	66 (30+36)	300	1.8 (1.36)	3.7 (1.94)	1.6 (1.28)	3.3 (1.83)	1.7 (1.32)	3.6 (1.91)
T_4	Triflumezopyrim 10.6% SC	25	235.8	1.9 (1.40)	3.9 (1.99)	1.8 (1.36)	3.2 (1.80)	1.9 (1.40)	3.8 (1.96)
T_5	Spinetoram 12% SC	30	250	2.1 (1.47)	3.6 (1.91)	1.9 (1.40)	3.0 (1.75)	1.7 (1.32)	4.2 (2.06)
T_6	Fipronil 5% SC	75	1500	2.0 (1.43)	3.2 (1.80)	1.7 (1.32)	2.6 (1.63)	1.6 (1.28)	3.3 (1.83)
T_7	Untreated Control	-	-	2.2 (1.50)	3.8 (1.96)	2.0 (1.43)	3.9 (1.99)	2.2 (1.50)	4.3 (2.09)
	CD @ 5%			**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Data in parentheses are√(x+0.5) transformed values; NS-Non significant; DBT: Days before treatment; DAT: Days after Treatment

Table 9: Impact of triflumezopyrim 10% + spinetoram 12% WDG on grain yield of paddy during *kharif* 2019 and *rabi* 2020.

Tr. No.	Treatment	Dose (g ai ha^{-1})	Formulation(g or ml ha^{-1})	Yield (tha^{-1})		
				kharif 2019	*rabi* 2020	Mean
T_1	Triflumezopyrim 10% + Spinetoram 12% (22%) WDG	44 (20+24)	200	3.40	3.94	3.7
T_2	Triflumezopyrim 10% + Spinetoram 12% (22%) WDG	55 (25+30)	250	3.70	4.37	4.0
T_3	Triflumezopyrim 10% + Spinetoram 12% (22%) WDG	66 (30+36)	300	4.00	4.53	4.3
T_4	Triflumezopyrim 10.6% SC	25	235.8	3.29	3.78	3.5
T_5	Spinetoram 12% SC	30	250	3.40	3.66	3.5
T_6	Fipronil 5% SC	75	1500	3.35	3.55	3.5
T_7	Untreated Control	-	-	2.90	3.10	3.0
	CD @ 5%			**0.37**	**0.25**	**0.31**

CONCLUSION

The present investigation on relative toxicity of triflumezopyrim 10% + spinetoram 12% (22%) WDG conducted during *kharif*, 2019 and *rabi* 2020 showed that triflumezopyrim 10% + spinetoram 12% (22%) WDG provided effective control of leaf folder and brown planthopper. Further, triflumezopyrim 10% + spinetoram 12% (22%) WDG @ 55g ai ha^{-1} has no significant difference with triflumezopyrim 10% + spinetoram 12% (22%) WDG @ 66g ai ha^{-1} w.r.t. safety to the predatory mirid bug, *Cyrtorhinus lividipennis* and wolf spider, *Pardosa pseudoannulata* and grain yield. Hence, triflumezopyrim 10% + spinetoram 12% (22%) WDG@ 55 g aiha^{-1} may be recommended to manage leaf folder and brown planthopper in rice.

FUTURE SCOPE

Based on the current research findings, the future research should be oriented on the drone-based pesticide application of the tested product in rice to standardize the effective dose, droplet size and other parameters required for registration of the pesticide for application through Unmanned Aerial Vehicle. In addition, the future research on the different crops need to be extended and the effective doses of the product may be standardized.

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