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Safety of thiamethoxam to *Cyrtorhinus lividipennis* Reuter (Hemiptera: Miridae), a predator of brown planthopper, *Nilaparvata lugens* (Stål) in rice

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ABSTRACT: **In greenhouse studies, thiamethoxam at 50, 25 and 12 ppm, imidacloprid at 50 ppm, fipronil at 100 ppm and the check insecticide acephate at 1200 ppm along with untreated control were assessed for their relative safety to nymphs and adults of green mirid bug *Cyrtorhinus lividipennis* Reuter, an effective predator of brown planthopper. For the adults of *C. lividipennis*, thiamethoxam at 25 ppm and 12 ppm was as safe as imidacloprid 50 ppm but less safer than acephate 1200 ppm. However, fipronil at 100 ppm and thiamethoxam at 50 ppm were less safe. For the nymphs, thiamethoxam at 12 ppm was as safe as imidacloprid 50 ppm and fipronil 100 ppm but less safer than acephate 1200 ppm. Thiamethoxam at 25 and 50 ppm was less safer than all other treatments.**

KEY WORDS: *Cyrtorhinus lividipennis*, insecticides, *Nilaparvata lugens*, rice, safety

Rice brown planthopper (BPH), *Nilaparvata lugens* (Stål) is one of the most important pests of rice sometimes inflicting severe losses. BPH damages rice by sucking plant sap and causes hopper-burn. Although cultural practices and varietal resistance are employed to check the damage by BPH, use of insecticides is one of the major tactics employed by farmers to minimize the losses to rice from this pest.

The insecticides used for BPH management shall be less toxic to its natural enemies in general and its major predator, mirid bug *Cyrtorhinus lividipennis* Reuter in particular. There are conflicting reports in literature on the safety of insecticides to *C. lividipennis*. Mochida *et al.* (1984) reported that granular insecticides applied to rice field did not appreciably reduce mirid bug populations. Similar observations were made by Rajendram (1994) with regard to carbofuran granules. Even carbamates, BPMC or growth regulators, buprofezin did not exert considerable adverse effect on *C. lividipennis* (Litsinger *et al.*, 1985). However, spray formulation of monocrotophos was reported to be highly toxic to mirid bug predator under green house conditions (Chelliah and Rajendran, 1984) as well as field conditions (Saxena *et al.*, 1989). Sontake (1993) observed that chlorpyriphos alone and in combination with neem oil was toxic to *C. lividipennis*. Heinrichs *et al.* (1979) reported that a synthetic pyrethroid deltamethrin exhibited more persistent toxicity to *C. lividipennis* than methyl

parathion and diazinon. Sometimes even granular formulations like cartap adversely affected *Cyrtorhinus* populations (Litsinger *et al.*, 1985). Heinrichs *et al.* (1980) and Mochida *et al.* (1982) reported that acephate was less toxic to *C. lividipennis* and its toxicity persisted for up to 5 days. Regarding imidacloprid, Mao and Liang (1995) reported that application of imidacloprid at 300, 450 and 600g a. i. / ha of rice nursery caused significant mortality in hemipteran predators. Penthoate, imidacloprid and deltamethrin were toxic to *C. lividipennis* when the insects were dipped in insecticidal emulsion and in the filed its abundance was reduced to a low level in all insecticide treated plots except those treated by buprofezin (Tanaka *et al.*, 2000).

Thiamethoxam (Actara 25 WG), a nitroguanidine compound, is one of the very effective insecticides against BPH recording 92 per cent mortality of hoppers at multilocation trials (DRR, 1999). It controls organophosphate, carbamate and pyrethroid resistant strains of sucking and chewing insects.

The insecticide was effective at 25g a. i. / ha as spray compared to 500g a. i. / ha of traditional insecticides utilized in rice resulting in very low environmental burden. Imidacloprid gave season long control of *N. lugens* following a single application on rice at 200g a. i. per kg (Iwaya *et al.*, 1998). However, in view of the varied effects of different insecticides with regard to their safety to mirid bug predator and lack of information on the safety of thiamethoxam to *C. lividipennis* the present studies were conducted under greenhouse conditions at Directorate of Rice Research to assess the initial and residual toxicity of thiamethoxam as spray to the major predator of BPH namely nymphs and adults of *C. lividipennis*.

MATERIALS AND METHODS

Rearing

Rice plants of TN1 variety were raised in the greenhouse and maintained according to their age. BPH was reared on 40-day-old rice plants in wooden cages in greenhouse. *C. lividipennis* bugs were reared on the rice plants preoviposited by BPH. The adult mirid bugs were confined to these plants for 2-3 days for oviposition and allowed for required period in separate cages to obtain nymphs or adults of specified age. Rice plants and the insects were confined and reared in the greenhouse at 30 ± 5^{0}C and 60 ± 10 per cent relative humidity.

Thiamethoxam (Actara 25 WG) at 50 ppm; imidacloprid (Confidor 200 SL) at 50 ppm, fipronil (Regent 5 SC) 100 ppm and acephate (Starthene 75 WP) at 1200 ppm were evaluated along with untreated control. To gain more detailed information on thiamethoxam, two additional concentrations of 25 and 12 ppm were also involved in the experiment. All the treatments were replicated four times.

The insecticides at specified concentrations were sprayed up to run-off stage on 40-day-old potted rice plants. The insects were planned for confinement on TN1 plants at 1, 7, 14, 21 and 28 days after spraying and separate sets were maintained for each day of confinement. Rice plants were pre-oviposited by BPH before spraying in the case of releases 1 and 7 days after spraying whereas they were oviposited by BPH after spraying in the case of releases 14, 21 and 28 days after spraying. Ten *C. lividipennis* nymphs (7-8 days old) or adults (2-3 days old) were confined each time with the help of suitable mylar cages and observations on mortality were recorded after 24, 48 and 72 hours of exposure each time. Separate experiments were conducted with nymphs and adults.

Persistent toxicity (PT) values were calculated for each exposure period *viz.*, 24, 48 and 72 hours separately according to Pradhan (1967). The mortality figures were converted into percentages and transformed into angular values before subjecting to analysis of variance. PT values were subjected to square root transformation. All the data were analyzed in Completely Randomized Block Design (CRBD) and the means were separated by least significant difference (l. s. d.) method (Cochran and Cox, 1957).

RESULTS AND DISCUSSION

Safety of insecticides to adults of *C..lividipennis*

The results presented in Table 1a & 1b revealed that all the insecticides registered almost cent per cent mortality of *C. lividipennis* adults for up to 7 days after spraying as compared to 0.0 per cent mortality in untreated control. After 21 days of spraying, thiamethoxam at 50, 25 and 12 ppm recorded 22.5 to 27.5 per cent mortality at 24 hours exposure and was on par with imidacloprid 50 ppm (20 % mortality) and acephate 1200 ppm (12.5 % mortality) but significantly better than fipronil 100 ppm (60 % mortality). After 28 days, thiamethoxam at 25 and 12 ppm registered only 12.5 and 5 per cent mortality and was on par with imidacloprid 50 ppm (7.5 % mortality), fipronil 100 ppm (15 % mortality) and acephate 1200 ppm (0.0 % mortality). However, persistent toxicity values at 24 hours expopsure revealed that thiamethoxam at 25 ppm (PT value of 1848) and 12 ppm (PT value of 1751) were on par with imidacloprid 50 ppm (PT value of 1793) with regard to their safety to *C. lividipennis* adults but not comparable with acephate 1200 ppm (PT value of 1182). However, fipronil at 100 ppm (PT value of 2016) and thiamethoxam at 50 ppm (PT value of 2394) were less safe to the adults of *C. lividipennis*.

Safety of insecticides to nymphs of *C. lividipennis*

Initially, one day after exposure, all the insecticidal treatments recorded cent per cent mortality of *C. lividipennis* nymphs within 24

Table 1a. Effect of insecticides on adults of *C. Lividipennis* in terms of percentage mortality and persistent toxicity

Treatment	Per cent mortality (after days)								
	1			7			14		
	24h	48h	72h	24h	48h	72h	24h	48h	72h
Thiamethoxam 50 ppm	100a	100a	100a	100a	100a	100a	100a	100a	100a
Thiamethoxam 25 ppm	100a	100a	100a	100a	100a	100a	100a	100a	100a
Thiamethoxam 12 ppm	100a	100a	100a	100a	100a	100a	100a	100a	100a
Imidacloprid 50ppm	100a	100a	100a	100a	100a	100a	100a	100a	100a
Fipronil 100ppm	100a	100a	100a	100a	100a	100a	100a	100a	100a
Acephate 1200ppm	100a	100a	100a	100a	100a	100a	12.5c	87.5b	87.5b
Control (untreated)	0b	0b	0b	0b	0b	0b	0d	7.5c	17.5c

The values in each column followed by the same letter are not significantly different (P=0.05)

Table 1b. Effect of insecticides on adults of *C. lividipennis* in terms of percentage mortality and persistent toxicity

Treatment	Per cent mortality (after days)						Persistent toxicity		
	21			28					
	24h	48h	72h	24h	48h	72h	24h	48h	72h
Thiamethoxam 50 ppm	0b	42.5b	55b	32.5b	32.5b	32.5b	700a	2100b	2170a
Thiamethoxam 25 ppm	7.5b	100a	100a	12.5bc	92.5a	100a	1848bc	2758a	2800a
Thiamethoxam 12 ppm	22.5b	100a	100a	5cd	35c	100a	1751c	2436ba	2800a
Imidacloprid 50ppm	20b	100a	100a	7.5bc	52.5c	100a	1793c	2534ab	2800a
Fipronil 100ppm	60a	100a	100a	15b	75b	100a	2016b	2660ab	2800a
Acephate 1200ppm	12.5b	60a	100a	0d	2.5d	22.5b	1182d	1741c	2464bb
Control (untreated)	0b	0b	0b	0d	0b	5c	42e	98d	182c

The values in each column followed by the same letter are not significantly different (P=0.05).

hours of exposure as compared to 0.0 per cent in untreated control. After 7 days, thiamethoxam at 12 ppm exhibited 50 per cent mortality within 24 hours exposure and was on par with imidacloprid 50 ppm (37.5 % mortality) but less safer than fipronil 100 ppm (20 % mortality) and acephate 1200 ppm (2.5 % mortality) (Table 2a). However, after 21 days of treatment, thiamethoxam at 50 and 25 ppm showed 32.5 and 27.5per cent mortality within 24 hours exposure and was on par with imidacloprid 50 ppm (40 % mortality) and fipronil 100 ppm (30 % mortality) but less safer than acephate at 1200 ppm (2.5 % mortality). After 28 days of spraying thiamethoxam at 50 and 25 ppm registered 45 per cent and 30 per cent mortality of mirid bug nymphs at 48 hours exposure and was on par with imidacloprid 50 ppm (27.5 % mortality) and fipronil (17.5 % mortality) but less safer than acephate 1200 ppm (2.5 % mortality). Persistent toxicity values (Table 2b) at 24 hours exposure revealed that thiamethoxam at 12 ppm (PT value of 1342) was on par with imidacloprid 50 ppm (PT value of 1284) and fipronil 100 ppm (PT value of 1126) with regard to their safety to nymphs of *C. lividipennis*. However, thiamethoxam even at the lowest concentration of 12 ppm could not be compared to acephate (PT value of 171).

From the overall results with regard to the safety of thiamethoxam to both adults and nymphs of mirid bug *Cyrtorhinus lividipennis*, it can be said that thiamethoxam at 25 ppm and 12 ppm was on par with imidacloprid 50 ppm and fipronil

Table 2a. Effect of insecticides on nymphs of *C. lividipennis* in terms of percentage mortality and persistent toxicity

Treatment	Per cent mortality (after days)								
	1			7			14		
	24h	48h	72h	24h	48h	72h	24h	48h	72h
Thiamethoxam 50 ppm	100a	100a	100a	100a	100a	100a	100a	100a	100a
Thiamethoxam 25 ppm	100a	100a	100a	100a	100a	100a	100a	100a	100a
Thiamethoxam 12 ppm	100a	100a	100a	50b	100a	100a	100a	100a	100a
Imidacloprid 50ppm	100a	100a	100a	37.5b	100a	100a	52.5b	75b	100a
Fipronil 100ppm	100a	100a	100a	20c	100a	100a	65b	97.5ab	100a
Acephate 1200ppm	100a	100a	100a	2.5d	7.5b	10b	12.5c	27.5c	100a
Control (untreated)	0b	0b	0b	0d	0c	0c	0c	0d	17.5b

The values in each column followed by the same letter are not significantly different (P=0.05).

Table 2b. Effect of insecticides on nymphs of *C. lividipennis* in terms of percentage mortality and persistent toxicity

Treatment	Per cent mortality (after days)						Persistent toxicity		
	21			28					
	24h	48h	72h	24h	48h	72h	24h	48h	72h
Thiamethoxam 50 ppm	32.5a	85b	100a	22.5a	45a	100a	100a	100a	100a
Thiamethoxam 25 ppm	27.5ab	90ab	100a	0c	30ab	62.5bc	1720a	2408a	2590a
Thiamethoxam 12 ppm	12.5bc	55c	100a	0c	10cd	50c	1342b	1982a	2520a
Imidacloprid 50ppm	40a	100a	100a	7.5b	27.5ab	75b	1284b	2240a	2660a
Fipronil 100ppm	30ab	100a	100a	0c	17.5bc	100a	1126b	2324a	2800a
Acephate 1200ppm	2.5cd	7.5d	100a	0c	2.5de	15d	171c	506b	322.5b
Control (untreated)	0d	7.5d	10d	0c	0e	2.5e	0d	42c	70c

The values in each column followed by the same letter are not significantly different (P=0.05).

100 ppm, but less safer than acephate 1200 ppm.

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