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Relative safety of selected acaricides to three hemipteran natural enemies of planthoppers in rice ecosystem

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ABSTRACT: **Greenhouse studies on the toxicity of twelve selected acaricides to hemipteran predators of planthoppers in rice *viz.*, green mirid bug (*Cyrtorhinus lividipennis*); brown mirid bug (*Tytthus parviceps*) and veliid bug (*Microvelia douglasi atrolineata*) revealed that fenpropathrin at 150 ppm and diafenthiuron at 450 ppm were highly toxic to these predators and need to be avoided in mite pest management programmes in rice. Spiromesifen at 72 ppm, pyriproxifen at 75 ppm, milbemectin at 2.5 ppm and dicofol at 500 ppm were less toxic to these predators and can be preferred. Other acaricides like profenophos (500 ppm), ethion (500 ppm), propargite (570 ppm), abamectin (10 ppm) and fenazaquin (125 ppm) were moderately toxic to these predators and can be selectively used depending on their potential toxicity to the mite species to be tackled in rice ecosystem.**

KEY WORDS: Acaricides, *Cyrtorhinus lividipennis*, *Microvelia douglasi atrolineata*, mites, rice, toxicity, *Tytthus parviceps*

INTRODUCTION

Among the mite species attacking rice crop, leaf mite, *Oligonychus indicus* (Hirst) and panicle mite, *Steneotarsonemus spinki* Smiley are the most important causing economic loss in many rice growing tracts in India. Although preliminary attempts were made to exploit varietal resistance and biological control in managing these mite pests (Lo and Ho, 1979, 1980; Ramos *et al.*, 2001), use of acaricides continues to be the most practical way under farmer's field situations. It is important to evaluate the safety of these acaricides to natural enemies of key pests before they are recommended to the farmers.

Green mirid bug, *Cyrtorhinus lividipennis* Reuter and brown mirid bug, *Tytthus parviceps* (Reuter) are very important predators on eggs and early instar nymphs of brown planthopper, *Nilaparvata lugens* (Stål) and white backed planthopper, *Sogatella furcifera* (Horváth) (Basilio and Heong, 1990; Pathak and Saha, 1976). Veliid bug, *Microvelia douglasi atrolineata* is found on water surface in flooded rice fields and feeds on nymphs of BPH and WBPH falling on water at basal portion of rice plants. There are several instances where the use of some insecticide molecules, particularly synthetic pyrethroids led to resurgence of *N. lugens* and *S. furcifera* resulting in 'hopper burn' and complete loss of rice crop. Destruction of natural enemies has been observed to be responsible for BPH resurgence (Heinrichs *et al.*, 1982; Krishnaiah and Kalode, 1987). Keeping the above points in view, the present investigations have been carried out at DRR headquarters, Rajendranagar, Hyderabad to assess the safety/ toxicity of selected new acaricides to the predators *viz*., *C. lividipennis*, *T. parviceps* and *M. douglasi atrolineata*, under glasshouse conditions.

MATERIALS AND METHODS

Twelve acaricides belonging to different chemical groups have been tested for their toxicity to three hemipteran predators present in the rice ecosystem *viz*., green mirid bug, *C. lividipennis*, brown mirid bug, *T. parviceps* and veliid bug, *M. douglasi atrolineata*. The concentrations were selected as per the recommendations of the manufacturers (Table1). The tests were carried out under controlled glasshouse conditions at a temperature of 30 $\pm$ 5^{0}C and RH of 60 $\pm$ 10 per cent.

Rearing of insects and conducting toxicity tests against *C. lividipennis* and *T. parviceps*

C. lividipennis and *T. parviceps* were reared separately on rice plants of TN1 variety which were pre-oviposited by their natural host insect, brown planthopper (BPH), *N. lugens*. BPH was reared and maintained on 40-day-old rice plants in wooden cages in glasshouse. The adults of *C. lividipennis* were confined to BPH pre-oviposited plants for 2-3 days for oviposition and allowed for required period in separate cages to obtain nymphs or adults of specific age.

The acaricides at specific concentrations were sprayed up to run-off stage on 40-day-old potted rice plants. The mirid bugs were confined 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 case of releases 1 and 7 days after spraying, whereas they were oviposited by BPH after spraying in case of releases 14, 21 and 28 days after spraying. This was necessary to avoid death of BPH adults before oviposition. Twenty *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 24, 48 and 72 hours after exposure each time. Separate experiments were conducted with nymphs and adults. The procedure for rearing and testing of acaricides for *T. parviceps* remained similar to *C. lividipennis*.

Rearing the insects and conducting tests with *M. douglasi atrolineata*

M. douglasi atrolineata bugs were collected from water in the trays used for rearing planthoppers. The adults of the predator thus collected were used for toxicity tests with acaricides. The acaricide emulsions/ solutions at specific concentrations were made in water (Table 3). Ten ml of each of the emulsion/ solution was added to one litre of water contained in a two litre capacity plastic pot (Jhansi Lakshmi *et al*., 1997). Twenty *Microvelia* adults were released on the water surface and covered with muslin cloth to prevent escape of bugs and also to prevent contamination from outside. Brown planthopper nymphs were provided as prey. The observations were recorded 24, 48 and 72 hours after each release. Mortality of *Microvelia* was assessed at 1, 7, 14, 21 and 28 days after treating with acaricides.

In case of all the above predators, persistent toxicity (PT) values were calculated for each acaricide and each exposure period *viz*., 24, 48 and 72 hours separately according to Pradhan (1967). Higher PT values indicated the toxicity for longer duration after application of the chemical. PT values were subjected to square root transformation and analyzed in a complete randomized block design and means were separated by DMRT (Cochran and Cox, 1957).

RESULTS AND DISCUSSION

The data on relative persistent toxicity up to 28 days after treatment of different acaricides to three predators *viz*., *C. lividipennis* (nymphs and adults), *T. parviceps* (nymphs and adults), *M. douglasi* (adults) at exposure periods of 24, 48 and 72 hours separately are presented in Tables 1, 2 and 3. Critical analysis of the data revealed that fenpropathrin (150 ppm) and diafenthiuron (450 ppm) were highly toxic to nymphs and adults of *C. lividipennis* (Table 1) recording PT values of 840

Table 1. Relative persistent toxicity of selected acaricides to green mirid bug, *C. lividipennis*

Treatment	Conc. (a. i.)	*Cyrtorhinus lividipennis*					
		Nymphs			Adults		
		24h	48h	72h	24h	48h	72h
Profenophos (Carina 50EC)	500 ppm	91 (9.55)[d]	684 (26.14)[c]	849 (29.13)[d]	30 (5.29)[c]	109 (9.15)[de]	403 (19.13)[de]
Ethion (Fosmite 50EC)	500 ppm	59 (7.66)[de]	295 (17.16)[ef]	749 (27.36)[d]	2.5 (0.79)[cd]	260 (15.43)cd	812 (28.41)[c]
Propargite (Omite 57 EC)	500 ppm	0 (0)[g]	224 (14.95)[fg]	503 (22.42)[e]	35 (2.95)[c]	79 (7.61)de	371 (18.81)[e]
Propargite (Simba 57 EC)	500 ppm	25 (4.95)[efg]	179 (13.36)[g]	357 (18.89)[ef]	35 (2.95)[c]	117 (9.04)de	353 (18.70)[e]
Spiromesifen (Oberon 240 SC)	72 ppm	4 (1.93)[fg]	31 (5.53)[h]	225 (14.99)[g]	0 (0)[d]	210 (12.46)[cd]	476 (21.64)[de]
Fenpropathrin (Meothrin 30 EC)	150 ppm	1857 (43.09)[a]	2170 (46.58)[a]	2408 (49.07)[a]	868 (29.46)[a]	1498 (38.63)[a]	2296 (47.91)[a]
Milbemectin (Milbeknock 1%)	2.5 ppm	2.5 (1.59)[fg]	187 (13.68)[fg]	308 (17.54)[fg]	2.5 (0.79)[cd]	159 (12.33)[cd]	392 (19.72)[de]
Abamectin (Vertimec 1.9 EC)	10 ppm	31 (5.53)[def]	433 (20.81)[de]	1092 (33.04)[c]	131 (11.23)[b]	398 (19.79)[bc]	1078 (32.72)[bc]
Pyriproxifen (Admiral 10EC)	75 ppm	16.9 (4.11)[efg]	187 (13.68)[fg]	476 (21.81)[e]	0 (0)[d]	180 (13.05)[cd]	560 (23.62)[d]
Fenazaquin (Magister 10 EC)	125 ppm	157 (12.54)[c]	657 (25.63)[cd]	1372 (37.04)[b]	153 (11.97)[b]	652 (25.48)[b]	1162 (34.07)[b]
Diafenthiuron (Polo 50WP)	450 ppm	1317 (36.29)[b]	1365 (36.94)[b]	1603 (40.03)[b]	840 (28.95)[a]	1379 (37.09)[a]	2142 (46.27)[a]
Dicofol (Kel-thane 18.5 EC)	500 ppm	0 (0)[g]	221 (14.84)[fg]	350 (18.7)[ef]	0 (0)[d]	117 (9.33)[de]	476 (21.80)[de]
Untreated control		1 (1.11)[g]	58 (7.63)[h]	93 (9.62)[h]	0 (0)[d]	18 (2.091)[e]	55 (5.91)[f]

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

Figures in parentheses are arcsine-transformed value.

to 1857 as compared to the PT value of "0" in check acaricide dicofol (500 ppm) at 24 hours exposure. They were highly toxic to nymphs and adults of *T. parviceps* recording PT values of 1481 to 2800, respectively (Table 2) as compared to the PT value of 367 to 502 in check acaricide dicofol (500 ppm) and against adults of *M. atrolineata* with a PT value of 2800 (Table 3) at the same exposure period as compared to the PT value of 502 in check acaricide, dicofol.

Among the other acaricides, spiromesifen belonging to new group of ketoenols at 72 ppm was least toxic to nymphs and adults of *C. lividipennis* recording a PT value of 0 to 4 at 24 hours exposure and 225 to 476 at 72 hours exposure.

Table 2. Relative persistent toxicity of selected acaricides to brown mirid bug, *Tytthus parviceps*

Treatment	Conc. (a. i.)	*Tytthus parviceps*					
		Nymphs			Adults		
		24h	48h	72h	24h	48h	72h
Profenophos (Carina 50EC)	500 ppm	509 (22.42)cd	553 (23.41)d	793 (27.99)d	633 (24.54)d	1306 (35.99)cd	1407 (37.48)c
Ethion (Fosmite 50EC)	500 ppm	293 (16.94)de	545 (23.22)d	927 (30.26)d	805 (28.34)c	1575 (39.66)bc	1918 (43.75)b
Propargite (Omite 57 EC)	500 ppm	270 (14.55)e	573 (22.58)d	732 (27.00)de	249 (15.06)ef	595 (24.27)gh	1047 (32.28)cde
Propargite (Simba 57 EC)	500 ppm	478 (21.64)cd	935 (30.36)c	1449 (37.99)c	159 (10.05)g	484 (21.75)h	766 (27.55)f
Spiromesifen (Oberon 240 SC)	72 ppm	128 (10.89)e	234 (15.07)e	532 (23.05)e	195 (13.19)f	813 (28.08)fg	1323 (36.33)cd
Fenpropathrin (Meothrin 30 EC)	150 ppm	2800 (52.91)a	2800 (52.91)a	2800 (52.91)a	2436 (49.27)a	2758 (52.51)a	2800 (52.91)a
Milbemectin (Milbeknock 1%)	2.5 ppm	314 (17.2)de	819 (28.6)cd	894 (29.89)d	71 (6.54)h	524 (22.72)h	845 (28.52)ef
Abamectin (Vertimec 1.9 EC)	10 ppm	840 (28.48)c	1575 (39.53)b	2205 (46.91)b	210 (14.32)f	643 (25.15)gh	1146 (33.76)cde
Pyriproxifen (Admiral 10EC)	75 ppm	279 (16.49)de	539 (23.15)d	714 (26.61)de	229 (13.41)f	523 (22.72)h	681 (31.74)def
Fenazaquin (Magister 10 EC)	125 ppm	1386 (37.21)b	1624 (40.26)b	1855 (43.05)b	572 (23.75)d	1099 (33.12)de	1374 (36.97)c
Diafenthiuron (Polo 50WP)	450 ppm	2800 (52.91)a	2800 (52.91)a	2800 (52.91)a	1481 (38.4)b	1869 (43.22)b	2107 (45.89)b
Dicofol (Kelthane 18.5 EC)	500 ppm	502 (22.39)cd	840 (28.96)cd	1260 (35.39)c	367 (17.61)e	953 (30.71)ef	1257 (35.33)cd
Untreated control		29 (3.35)f	40 (4.07)f	151 (10.53)f	1 (0.55)i	61 (6.67)i	251 (15.57)g

Note: Figures in a column followed by the same letter are not significantly different at P=0.05 by DMRT.
Figures in parentheses are arcsine-transformed value.

while it was moderately toxic to nymphs and adults of *T. parviceps* and adults of *M. atrolineata* (PT value of 532 to 1323 at 72 hours exposure). Milbemectin (belonging to milbemycin group) also exhibited low degree of toxicity to *C. lividipennis* (PT value of 308 to 392 at 72 hours exposure) but moderately toxic to other predators tested (PT value of 845 to 894 at 72 hours exposure). Other fermentation product, abamectin (10 ppm) exhibited moderate to high toxicity to all the predators (PT value of 1078 to 2205 at 72 hours exposure). Among the other molecules, pyriproxifen, a growth regulator at 75 ppm was moderately toxic to all predators (PT value of 476 to 714 at 72 hours exposure) while fenazaquin belonging to Quinazoline group at 125 ppm exhibited severe

Table 3. Relative persistent toxicity of selected acaricides to velid bug, *Microvelia douglassi*

Treatment	Conc. (a. i.)	*Microvelia douglassi* (Adults)		
		24h	48h	72h
Profenophos (Carina 50EC)	500 ppm	509(22.42)^{cd}	553(23.41)^{de}	793(27.99)^{de}
Ethion (Fosmite 50EC)	500 ppm	293(16.94)^{de}	545(23.22)^{de}	927(30.26)^{d}
Propargite (Omite 57 EC)	500 ppm	270(14.55)^{e}	573 (22.58)^{de}	732 (27)^{de}
Propargite (Simba 57 EC)	500 ppm	478 (21.64)^{cd}	934 (30.36)^{c}	1449 (37.99)^{c}
Spiromesifen (Oberon 240 SC)	72 ppm	128 (10.89)^{e}	234 (15.07)^{f}	532 (23.05)^{e}
Fenpropathrin (Meothrin 30 EC)	150 ppm	2800 (52.91)^{a}	2800 (52.91)^{a}	2800 (52.91)^{a}
Milbemectin (Milbeknock 1%)	2.5 ppm	314 (17.20)^{de}	819 (28.60)^{cde}	894 (29.89)^{d}
Abamectin (Vertimec 1.9 EC)	10 ppm	840 (28.48)^{c}	1575(39.53)^{b}	2205 (46.91)^{b}
Pyriproxifen (Admiral 10EC)	75 ppm	279 (16.49)^{de}	539 (23.15)^{de}	714 (26.61)^{de}
Fenazaquin (Magister 10 EC)	125 ppm	1386 (37.21)^{b}	1624 (40.26)^{b}	1855 (43.05)^{b}
Diafenthiuron (Polo 50WP)	450 ppm	2800 (52.91)^{a}	2800 (52.91)^{a}	2800 (52.91)^{a}
Dicofol (Kelthane 18.5 EC)	500 ppm	502 (22.39)^{cd}	840 (28.96)^{cd}	1260 (5.39)^{c}
Untreated control		29 (3.35)^{f}	40(4.07)^{g}	151(10.53)^{f}

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

Figures in parentheses are arcsine-transformed value.

toxicity to all the predators (PT value of 1372 to 1855 at 72 hours exposure). Among the old molecules, the two organophosphates, profenophos and ethion (each at 500 ppm) expressed moderate to severe toxicity against all the predators (PT value of 403 to 1575 at 72 hours exposure). Considerable differences were also observed between the two formulations of propargite belonging to sulfite ester group (Omite 57 EC and Simba 57 EC) with regard to their toxicity to the natural enemies of planthoppers (Table 1).

A perusal of the literature on the toxicity/ safety of any of these acaricides to the three predators revealed no information. Castane and Arino (1996) studied the residual toxicity of several plant protection chemicals to 3rd–4th instar nymphs of *Dicyphus tamaninii* on tomato leaves and observed that pyriproxifen (10 EC at 0.75 ml/ l) was harmless to the predator. Nemoto (1995) mentioned that milbemectin (0.1% solution of milbemectin emulsion) had minimal adverse effect on *Orius* spp., a predator on eggplant arthropods. Veire *et al.* (2002) mentioned that the acaricide pyriproxifen was harmless to the predatory bug, *O. laevigatus* while, diafenthiuron and abamectin were harmful to the predator. These findings indicated similar trend observed in our studies where milbemectin and pyriproxifen were relatively less toxic to all the three predators *viz.*, *C. lividipennis*, *T. parviceps*, *M. douglasi* than diafenthiuron and abamectin which exhibited more potential toxicity to all the three predators. The results with fenpropathrin are on expected lines as in general synthetic pyrethroids exhibited high toxicity to all the three predators involved in the present study (Ressig *et al.*, 1982; Fabellar and Heinrichs, 1984; Krishnaiah and Kalode, 1987).

Therefore, from the present studies it is suggested that fenpropathrin and diafenthiuron have to be avoided in mite pest management programmes in rice ecosystem, particularly when planthoppers and their predators exist in the ecosystem. Under such situations, other acaricides like spiromesifen, milbemectin or dicofol need to be preferred to have sound approach in rice IPM programmes. Other acaricides like profenophos, ethion, propargite, abamectin and fenazaquin can be selectively used in IPM programmes depending on their potential toxicity to the mite pest species that need to be tackled in rice ecosystem.

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