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BIOSAFETY OF COMMONLY USED INSECTICIDES TO NATURAL ENEMIES IN RICE ECOSYSTEM

M. SHANMUGA PREMA*, S. SRIDHARAN AND S. KUTTALAM
Department of Agricultural Entomology,
Tamil Nadu Agricultural University, Coimbatore - 641 003, Tamilnadu, INDIA
e-mail: prema.ms1990@gmail.com

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***Corresponding author**

ABSTRACT

The biosafety of fipronil 80 WG, chlorpyriphos 20 EC, dimethoate 30 EC and neem seed kernel extract (NSKE) 5 per cent to *Trichogramma chilonis* Ishii, *Telenomus sp.* and *Cyrtorhinus lividipennis* Reuter was studied under laboratory condition. The result revealed that, NSKE 5% was safe to *T. chilonis* with higher rate of parasitization (92.6%) and emergence (94.1%) followed by fipronil 80 WG @ 40 and 50g a.i.ha^{-1} which recorded 80 per cent parasitization of eggs and emergence of adult parasitoid. The adult emergence of *Telenomus sp.,* was maximum in NSKE 5% (74.33%) followed by fipronil 80 WG @ 40 and 50g a.i.ha^{-1} with respective parasitoid emergence of 59.33 and 55 per cent. Further, the mortality of mirid predator, *Cyrtorhinus lividipennis* Reuter was minimum 7.5 per cent in NSKE 5% treatment followed by fipronil 80 WG @ 40 and 50g a.i.ha^{-1} which recorded a mortality of 37.5 and 40 per cent, respectively. The deleterious subtle effect of NSKE 5% and fipronil 80 WG egg parasitoids and mirid predators showed their biosafety to natural enemies in rice ecosystem as compared to standard checks chlorpyriphos 20 EC @ 200g a.i./ha and dimethoate 30 EC @ 375g a.i./ha.

INTRODUCTION

Stem borer (*Scirpophaga incertulas* Walker), leaf folder (*Cnaphalocrosis medinalis* Gunee) and brown planthopper (*Nilaparvata lugens* Stal.) are the major pests of rice which causes yield loss up to 68 per cent (DRR, 2007). The rice ecosystem which harbours natural enemies like *Telenomus sp., Trichogramma chilonis* Ishii and predator like green mirid bug, *Cyrtorhinus lividipennis* Reuter provide natural control of leaf folder, stem borer and brown planthopper population, but constant disturbances to rice ecosystem using chemical pesticides upset the natural balance causing pest upsurgence. Synthetic pesticides like cartap hydrochloride 4G, carbofuran 3G, monocrotophos 36 SL, Quinalphos 25EC, chlorpyriphos 20EC , endosulfan 35EC , buprofezin have been tested for their bio efficacy against leaf folder, stem borer and brown planthopper (Virk and Sarao,2010; Abro *et al.,* 2013). The data on the biosafety of pesticides to natural enemies add value to their ideal characteristics to be included in the IPM. The biosafety of aqueous neem seed kernel extract and neem oil emulsion on the parasitisation and survival of *Trichogramma chilonis* was repeated by Jyothi *et al.*(2003). Similarly, the biosafety of acetamiprid 20SP and spinosad 98SC to green lacewing, *Chrysoperla carnea* was studied by Uthamasamy *et al.* (2003). Likewise, the safety of buprofezin (Applaud) to the egg parasitoid *T. chilonis* and the predator, *C. carnea* was tested by Balasubramanian and Regupathy (1993). Fipronil (Regent) is a promising pesticide used currently in rice ecosystem to check leaf folder, stem borer and brown planthopper. Mahal *et al.* (2008) reported that Fipronil 80 WG as one of the options to the farmers in selection of insecticides for effective control of stem borer and leaf folder on *basmati* rice. Hence, the biosafety of fipronil 80 WG against *Trichogramma chilonis* (An egg parasitoid of rice leaf folder), *Telenomus sp.* (An egg parasitoid of rice stem borer) and predatory mirid bug, *Cyrtorhinus lividipennis* on brown planthopper was studied with standard checks under laboratory condition at Department of Agricultural Entomology, Tamil Nadu Agricultural University (TNAU), Coimbatore.

MATERIALS AND METHODS

The laboratory experiments were conducted at the Department of Agricultural Entomology, TNAU, Coimbatore during 2013 - 2014. These treatments were imposed as per the treatment schedule given in table 1. The biosafety of different insecticide formulation were evaluated against natural enemies of rice pest.

Biosafety of insecticides to *Trichogramma chilonis*

Adult emergence of *Trichogramma chilonis*

The egg parasitoid, *Trichogramma chilonis* cultured in the biocontrol laboratory, Department of Agricultural Entomology, TNAU, Coimbatore was used for conducting the bioassay. The bioassay method described by Pandiyan *et al.* (2005) was adopted for *T. chilonis* with modifications. The biosafety of different insecticides were evaluated against *T. chilonis*, an effective parasitoid used against the eggs of leaf folder, *Cnaphalocrosis medinalis* in the rice ecosystem. There were six treatments and four replications. In the bioassay experiment conducted, the parasitized egg cards were tagged with the leaves of rice seedlings and the parasitized egg cards were sprayed with insecticides using atomizer. Distilled water was sprayed in untreated check. The treated egg cards were shade dried for 10 min and then kept in polythene bags of size 30 x 20 cm. The number of adult parasitoids emerged 48 hours after treatment (HAT) was recorded and per cent adult emergence worked out using the formula,

$$\text{Adult emergence (\%)} = \frac{\text{No. of wasps emerged}}{\text{Total no. of parasitized eggs in one cm}^2\text{ card}} \times 100$$

Parasitization of *Trichogramma chilonis*

The bioassay method described by Pandiyan *et al*. (2005) was adopted for *T. chilonis* with modifications. The effect of insecticides on the parasitization of *T. chilonis* was also tested. The fresh *Corcyra* eggs in cards were treated with different insecticides. There were six treatments and four replications. The sprayed cards were shade dried and kept in polythene bags (30 x 20cm size) along with parasitized egg card ready for emergence in 6:1 ratio. The newly emerged parasitoids were allowed for 48 hours to parasitize and then the adult parasitoids along with parasitoid card were removed. The number of parasitized eggs (eggs appearing black) was recorded after 4 days of parasitization. They were allowed to emerge and counted. Then per cent parasitization was worked out.

$$\text{\% parasitization} = \frac{\text{No. of parasitized eggs which showed adult emergence}}{\text{Total no. of Corcyra eggs exposed for parasitization}} \times 100$$

Impact of insecticides on adult emergence of *Telenomus sp.*

The naturally parasitized egg masses of stem borer were collected and kept in petriplates. The petriplates were provided with moist filter paper to avoid drying of leaves. After emergence of the adult parasitoid, the parasitoid was identified as *Telenomus sp*. with taxonomic characters in our Biosystematics lab, TNAU, Coimbatore. Naturally parasitized stem borer egg masses were collected to assess the impact of the insecticides on the adult emergence of *Telenomus sp*. The egg masses collected were treated with the insecticides as per the treatment schedule (Table 2), using an atomizer. Distilled water was sprayed in untreated check. The treatments were replicated four times and the treated egg masses were shade dried for 15 minutes and then kept in petriplates at the rate of 3 egg masses per petriplate. Then the eggs were observed for the emergence of parasitoids and the per cent emergence of egg parasitoids was worked out.

Effect of insecticides on predatory mirid bugs, *C. lividipennis*

Rice seedlings of 30 days old were used for the study. The root portion and the leaf portions were trimmed off and only 10cm of tiller stem was used for the treatment. Rice tillers with stem portions alone were dipped in the insecticides solution as per the treatment schedule and shade dried. The shade dried stems were then placed along with BPH in the test tube and closed with the muslin cloth. After feeding on insecticide treated stems for 2h, the BPH nymphs were transferred to new test tube with untreated stem and allowed to feed the plants which forms the food for mirid bugs. After 2 hours of release of BPH on untreated stem, the mirid bugs were released. The mortality of mirid bugs after 12 and 24 hours of release was calculated.

The data on per cent damage was transformed into arc sine values and were statistically analysed. The means were separated by least square means test (LSD) at $P < 0.05$ levels.

RESULTS AND DISCUSSION

Pesticidal effect on the emergence of *T. chilonis* adults

The effect of different insecticides on the emergence of *Trichogramma* adults is given in the table 1. The results indicated that NSKE 5 per cent treated eggs had adult emergence of 90 per cent which was on par with untreated control (95.6%). Fipronil 80 WG @ 40 and 50g a.i. ha^{-1} recorded 83 and 82.5 per cent adult emergence, respectively. The conventional insecticides, chlorpyriphos 20 EC at 200g a.i. ha^{-1} and dimethoate 30 EC at 375g a.i. ha^{-1} recorded the least adult emergence of 56 and 58.5 per cent, respectively.

Egg parasitization by *T. chilonis*

The NSKE 5 per cent recorded maximum parasitization of 92.6 per cent and found on par with untreated check (97.5%). The new test chemical fipronil 80 WG at 40 and 50g a.i. ha^{-1} effected 81.2 and 80.8per cent parasitization as compared to untreated check (97.5%). The conventional insecticides, chlorpyriphos 20 EC at 200g a.i. ha^{-1} and dimethoate 30 EC at 375g a.i.ha^{-1} recorded the least parasitization of 47.7 and 49.7 per cent, respectively. The NSKE 5 per cent had least impact compared to other insecticides.

Fipronil had little impact on the egg parasitoid, *T. chilonis* as compared to conventional insecticides. Fipronil 80 WG, at the recommended dose of 40 and 50 g a.i. ha^{-1} recorded 83 and 82.5 per cent adult emergence and 81.2 and 80.8 per cent parasitization, respectively. The present finding is in accordance with the reports of Xueping *et al*. (2012) who stated phenyl pyrazoles as the safest one to *Trichogramma sp.* Similarly, Hamon *et al*. (1996) also reported that fipronil at 64 and 75g a.i. ha^{-1} were apparently toxic to *Trichogramma pretiosum* (Riley) under laboratory condition but exhibited very low toxicity in the field conditions. Chlorpyriphos and dimethoate recorded the least egg parasitization of 47.7 and 49.7 per cent, respectively. Studies conducted by Tiwari and Khan (2002) revealed that the chlorpyriphos adversely affected the parasitization by *T. chilonis* at all the concentrations tested. Kakakhel and Hassan (2000) also reported that dimethoate at 25, 12.5 and 6.25 μl was found to be highly toxic with 100 per cent reduction in parasitization as compared to untreated control. The above findings are in consonance with the present results. The safety of neem seed kernel extract to *T. chilonis* reported by Xueping *et al*. (2012) was in line with the present study.

Pesticidal effect on the emergence of *Telenomus* adults

The result on the toxic effect of different insecticides on the adult emergence of *Telenomus sp*. was observed. NSKE 5 per cent treated egg masses showed an adult emergence of 74.33 per cent followed by the fipronil 80 WG at 40 and 50g a.i. ha^{-1} which recorded 59.33 and 55 per cent, respectively. The least per cent parasitoid emergence was observed in chlorpyriphos 20 EC (35.33%) and dimethoate 30 EC (32.61%). The result indicated that the conventional insecticides

Table 1: Biosafety of insecticides to *Trichogramma chilonis* Ishii

S.No.	Treatments	Dose(g a.i. ha $^{-1}$)	Adult emergence (%)	Corrected mortality (%)	Egg parasitisation (%)	Unparasitized egg(%)	Corrected mortality(%)
1.	Fipronil 80 WG	40	83.0^{c} (5.28)	15.82	81.2^{b} (5.16)	18.8	16.72
2.	Fipronil 80 WG	50	82.5^{c} (5.21)	16.32	80.8^{b} (5.16)	19.2	17.13
3.	Chlorpyriphos 20EC	200	56^{d}(4.29)	43.21	47.7^{c}(3.96)	52.3	51.08
4.	Dimethoate 30 EC	375	58.5^{d}(4.39)	40.67	49.7^{c} (4.04)	50.3	49.03
5.	NSKE 5 %	-	94.1^{a} (5.44)	4.56	92.6^{a} (5.52)	7.4	0.50
6.	Untreated control	-	98.6^{a}(5.61)	0	97.5^{a} (5.64)	2.5	0

Values in the column are mean of four replications; In a column means followed by a common letter are not significantly different at p = 0.05 by LSD; Figures in parentheses are arcsine √ Per cent transformed values.

Table 2: Biosafety of different insecticides against the emergence of *Telenomus* adults

S.No.	Treatments	Dose(g a.i. ha $^{-1}$)	Parasitoid emergence*(%)
1.	Fipronil 80 WG	40	59.33^{c}(7.69)
2.	Fipronil 80 WG	50	55.00^{c}(7.41)
3.	Chlorpyriphos 20EC	200	35.33^{d}(5.93)
4.	Dimethoate 30 EC	375	32.67^{d}(5.69)
5.	Neem seed kernel extract 5 %	-	74.33^{b}(8.62)
6.	Untreated control	-	4.38^{a}(9.09)

*Mean of four replications; HAT – Hour after treatment; In a column means followed by a common letter are not significantly different at P = 0.05 by LSD;Figures in parentheses are arcsine √ Per cent transformed values

Table 3: Biosafety of different insecticides to mirid bugs, *Cyrtrohinus lividipennis* Reuter

S.No.	Treatments	Dose(g a.i. ha $^{-1}$)	Mortality* (%)	
			12 HAT	24 HAT
1.	Fipronil 80 WG	40	25.0^{c}	37.50^{c}
2.	Fipronil 80 WG	50	27.5^{c}	40.00^{c}
3.	Chlorpyriphos 20EC	200	47.5^{e}	67.50^{d}
4.	Dimethoate 30 EC	375	35.0^{d}	55.00^{d}
5.	Neem seed kernel extract 5 %	-	2.50^{b}	7.50^{b}
6.	Untreated control	-	0.00^{a}	0.00^{a}

*Mean of four replications; HAT – Hour after treatment; In a column means followed by a common letter are not significantly different at P = 0.05 by LSD; Figures in parentheses are arcsine √ Per cent transformed values

chlorpyriphos and dimethoate had adverse effect on adult emergence of *Telenomus sp*. as compared to the new test chemical fipronil 80 WG which had moderate effect on the adult emergence. The botanical insecticide NSKE 5 per cent was found safe when compared to other chemical insecticides.

The findings were in line with Bastos *et al*. (2006) reported that alpha-cypermethrin, carbosulfan, deltamethrin, endosulfan, profenofos and zeta-cypermethrin were highly noxious to the parasitoid, significantly reducing the percentage of adult emergence and parasitism of *T. pretiosum* developing in *E. kuehniella* or *S. cerealella* eggs.

Pesticidal effect on the Predator, *C. lividipennis*

The toxic effect of different insecticide formulations to mirid bug predating on BPH nymphs is given in the table 3. Fipronil 80 WG at 40 and 50g a.i. ha^{-1} showed 37.5 and 40 per cent mortality as compared to untreated check with no mortality 24 hours after treatment. The conventional insecticides, chlorpyriphos 20 EC at 200g a.i. ha^{-1} and dimethoate 30 EC at 375g a.i. ha^{-1} recorded the highest mortality of 67.5 and 55 per cent, respectively. NSKE 5 per cent recorded the least mortality of 7.5 per cent and found highly safe to the predatory bugs at 24HAT. These findings were in line with Chelliah and Rajendran (1984) who reported that chlorpyriphos, quinalphos and monocrotophos were highly toxic to *C. lividipennis*. Similar finding was reported by Seetharamu *et al*. (2006) who stated that the insecticides ethofenprox 10 EC @1.5 ml/l (32.00) and fipronil 0.4 G @ 25 kg/ha (30.67) recorded highest population of mirid bugs at one day after application and found safer to mirid bug population in rice ecosystem whereas chlorpyriphos (2.5 ml/l) was found highly toxic to mirid bug by recording lowest population of 9.00, followed by imidacloprid (11.67). Ramakrishnan and Sridharan (2014) also reported the safety of the neem seed kernel 2.5 % extract and its combination products against natural enemies in curry leaf.

The results revealed that, NSKE 5 per cent treatment was highly safe as compared to the other insecticide molecules. Among the conventional insecticides tested, the new molecule fipronil had medium toxicity to predatory bugs. The newer molecule like fipronil has lesser impact and found to be moderately safe as compared to conventional insecticides.

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