Laboratory contact effect of some insecticides on predatory assasin bug, \textit{Rhynocoris marginatus} Fabricius (Reduviidae: Hemiptera)

LC Patel

DOI: https://doi.org/10.22271/chemi.2020.v8.i6k.10862

Abstract
Twenty two insecticides were evaluated against 4th instar nymphs of predatory \textit{Rhynocoris marginatus} in laboratory. Corrected mortality (E) was considered to group the treatments as harmless (E < 30%), slightly harmful (30 < E < 79%), moderately harmful (80 < E < 99%) and harmful (E > 99%) according to IOBC protocols. Result indicated no insecticide as harmful category. Moderately harmful with significantly at par mortality (85.74-81.85 %) found in 3 organophosphate insecticides such as chlorpyriphos, acephate 95 SG and quinalphos. The effect was slightly harmful with E ranged from 76.48–51.30 % by 7 insecticides such as bifenthrin, tolfenpyrad, fipronil, acepate 75 SP, lambda cyhalothrin, caretap hydrochloride and ethion + cypermethrin. Remaining 12 insecticides behaved as harmless against assassin predator with mortality varied from 27.22–5.37 %. Here the greatest safety found in thiacloprid followed by azadirachtin, acetamiprid, spirotetramat, imidacloprid, chlorfenapyr, chlorantraniliprole, flubendiamide, flubendiamide + thiacloprid, emamectin benzoate, spirotetramat + imidacloprid and ethiprole + imidacloprid.

Keywords: Insecticides, \textit{Rhynocoris marginatus}, Harmful, Effect, Assasin predator

Introduction
Assassin bugs or Reduviids (Hemiptera: Reduviidae) are predacious insects against many economically important pests. They are abundant in agro-ecosystems, semiarid zones, scrub jungles and tropical rainforest ecosystems (Ambrose, 1999; Sahayaraj, 2007) [2, 17]. They stalk and ambush the prey, finally inject the poison to kill it. The rostrum of these bugs is curved outwards from the head, a diagnostic feature of the insects belonging to this family (Sheikh et al., 2016) [19]. On the other hand, different insecticides also play major role for suppressing insect pests in crop field. But remarkable hazardous effect is also established due to more dependence on different chemical pesticides for crop pest management. There has been an intense requirement for environment-friendly and sustainable approaches through using as well as conserving naturally occurring bio-control agents, such as Reduvid predators. They occur in diverse habitats in agro-ecosystems and being exposed to insecticides that are used to control insect pests. Although insecticides are evaluated for their control potential against particular insect pests, their effects on biology and physiology of non-target beneficial insects like reduviid are neglected. In integrated pest management (IPM) programmes, incorporation of natural enemies is possible only when they were protected from insecticides used against insect pests. With the introduction of new agro-chemicals, the assessment of the potential effect of these chemicals on survival, dispersal and beneficial capacity of the natural enemies is essential to identify selective insecticides for incorporation in IPM programmes (Paul and Thyagarajan, 1992) [13]. Such an understanding of the mortality effect of some commonly used insecticides on one type of reduviid bug, \textit{Rhynocoris marginatus} would enable the selection of soft insecticides to protect beneficials and thereby to improve IPM.

Materials and Methods
Location of experiment
The experiment was conducted in entomological laboratory of College of Agriculture, Bidhan Chandra Krishi Viswavidyalaya, Farm Gate 1, Kalna Road, Burdwan sadar, 713101, West Bengal, India during spring season in 2019.
Rearing of predatory Assassin bug
The adult reduvid (Rhynocoris marginatus) cultures including males and females (1:1) was outsourced from National Institute of Plant Health Management (NIPHM), Hyderabad, India. It was used for mass multiplication under laboratory condition having temperature at 25 ± 2°C and relative humidity 75 ± 5% using larva of factitious host, Corcyra cephalonica. The collected predators were released in a circular plastic tray (15 cm diameter and 6 cm height) with 2 cm thick sterilized sand at bottom for mating. The tray was covered with a perforated lid for proper aeration. A small paper was kept inside the box for egg laying. The batch of eggs was kept for hatching into individual petri-plate (9 cm diameter) lined with slightly moist absorbent cotton and filter paper. After hatching first instars nymphs were transferred into another petriplate of same size and provided with small sized Corcyra larva for food. In this way, it was grown up to 2nd instars nymphs and during 3rd instars they were shifted to plastic tray as described earlier for adult rearing. They were grown up to 4th instars nymphal stage for ultimate use in the present experiment.

Rearing of host insect Corcyra cephalonica
This host insect Corcyra cephalonica was also multiplied on sterilized crushed maize grain using rearing box in laboratory at normal room temperature and humidity following the method as described by Wahengbam et al., 2018 [23].

Evaluation and observation of insecticides against predator (Assassin bug)
Twenty two different types (conventional, novel and mixed) and widely used insecticides (Table 1) were dissolved separately in water at their field recommended dose to obtain individual insecticide solution. One untreated control using normal water was also maintained as check. Ten (10) individuals of 4th instars nymphs of R. marginatus were taken with three (3) replications for each of twenty three (23) treatments and they were dipped in respective solution approximately for 30 seconds to judge its mortality effect against these said treatments. Observations on survival of R. marginatus were taken at 24 hours interval upto 2 days after treatment. The collected data were used for calculation of corrected percent (%) mortality for each treatment using Abbott’s formula (1925) [1] as follows.

| Insecticides                        | Concentration (%) | 1 DAT         | 2 DAT         | Average     | Toxicity class |
|-------------------------------------|-------------------|---------------|---------------|-------------|----------------|
| T1 = Thiacloprid 21.7 SC            | 0.2               | 3.33 (9.01)a  | 7.41 (14.63)b | 5.37 (12.57)g| 1              |
| T2 = Imidacloprid 17.8 SL           | 0.05              | 10.37 (16.96) | 11.11 (19.92) | 10.74 (19.26)g| 1              |
| T3 = Quinalphos 25 EC               | 0.2               | 71.11 (57.96) | 92.59 (77.33) | 81.85 (65.50)ab | 3              |
| T4 = Chlorpyriphos 20 EC            | 0.2               | 78.89 (63.44) | 92.59 (77.33) | 85.74 (68.90)a | 3              |
| T5 = Azadirachtin 1 EC              | 0.2               | 6.67 (11.67) | 7.41 (14.63) | 7.04 (13.97)g| 1              |
| T6 = Fipronil 5 SC                  | 0.15              | 53.70 (47.42) | 96.30 (83.66) | 75.00 (60.40)b | 2              |
| T7 = Acephate 35 SG                 | 0.2               | 74.81 (60.35) | 96.30 (83.66) | 85.56 (68.21)a | 3              |
| T8 = Flubendiamide 19.92 + Thiacloprid 19.92 SC | 0.1 | 3.33 (9.01)a | 25.93 (30.84) | 14.63 (22.82) | 1 |
| T9 = Spirotetramat 15 OD            | 0.1               | 7.04 (14.29) | 7.41 (14.63) | 7.22 (15.19)g| 1              |
| T10 = Chlorfenapyr 10 SC            | 0.2               | 10.74 (19.58) | 11.11 (17.48) | 10.93 (19.32)g| 1              |
| T11 = Ethion 40 + Cypermethrin 5 EC | 0.1               | 28.52 (32.52) | 74.07 (59.83) | 51.30 (46.03) | 2              |
| T12 = Bifenthrin 10 EC              | 0.2               | 7.41 (58.12) | 81.48 (65.14) | 76.48 (61.47)ab | 2              |
| T13 = Chlorantraniliprole 18.5 SC   | 0.03              | 7.04 (14.29) | 14.81 (22.77) | 10.93 (19.41)g| 1              |
| T14 = Spirotetramat 11.01 + Imidacloprid 11.01 SC | 0.2 | 17.78 (25.10) | 33.33 (35.38) | 25.56 (30.49) | 1              |
| T15 = Flubendiamide 20 WG            | 0.1               | 7.04 (14.29) | 14.81 (22.77) | 10.93 (19.38)g| 1              |
| T16 = Acephate 75 SP                 | 0.1               | 60.37 (51.35) | 85.19 (68.07) | 72.78 (58.98)bc | 2              |
| T17 = Cartap Hydrochloride 50 SP     | 0.1               | 46.30 (43.11) | 62.96 (52.85) | 54.63 (47.97) | 2              |
| T18 = Ethiprole 40 + Imidacloprid 40 WG | 0.1 | 21.11 (27.30) | 33.33 (35.38) | 27.22 (31.53)e | 1              |
| T19 = Lambda Cyhalothrin 5 EC       | 0.1               | 53.33 (47.21) | 70.37 (57.43) | 61.85 (52.15)cd | 2              |
| T20 = Emamectin Benzoate 5 SG       | 0.05              | 17.78 (25.10) | 33.33 (35.38) | 25.56 (30.49) | 1              |
| T21 = Tolfenpyrad 15 EC             | 0.15              | 60.37 (51.35) | 92.59 (77.33) | 76.48 (61.55)ab | 2              |
| T22 = Acetamiprid 20 SP             | 0.02              | 7.04 (14.29) | 7.41 (14.29) | 7.22 (14.03)g | 1              |
| T23 = Untreated Control (Water)     | -                 | 0.00 (4.05)  | 0.00 (4.05)  | 0.00 (4.05)  | -              |
| SEM (±)                             | -                 | 3.34          | 4.40          | 2.68         | -              |
| CD at 5 %                           | -                 | 9.53          | 12.55         | 7.63         | -              |

Figure in parenthesis indicates angular transformation, Mean followed by common letter are not significantly different at 5% level by DMRT. Mortality Effect (E) (according to IOBC protocols) - Classes: 1 = Harmless (E < 30%), 2 = Slightly Harmful (30 <E < 79%), 3 = Moderately Harmful (80 < E < 99%), 4 = Harmful (E > 99%) 

Mortality Effect (E) of each treatment on the said predator was commented according to IOBC protocols [Classes: 1 = Harmless (E < 30%), 2 = Slightly Harmful (30 <E < 79%), 3 = Moderately Harmful (80 < E < 99%), 4 = Harmful (E > 99%)] (Hassan et al., 1992).

Statistical analysis
Duncan’s Multiple Range Test (DMRT) using MSTATC was followed to find out the statistical variations among the different treatments after getting necessary transformed (angular) value for each of corrected percent (%) mortality.

Results and Discussion
The effect of twenty two insecticides on mortality of 4th instars nymphs of R. marginatus is mentioned in table 1. Comparing with untreated control, the percent mortality of the test predator at 1 and 2 days after treatment (DAT) varied significantly in most of the insecticidal treatments.
Mortality (%) of R. marginatus at 1 DAT
Among the twenty two insecticides, Chlorpyriphos 20 EC caused the highest mortality (78.89 %) of R. marginatus at 1 DAT. It was statistically at par with Acephate 75 SG (74.81%), Bifenthrin 10 EC (71.48 %) and Quinalphos 25 EC (71.11 %). Thereafter, more or less statistically at par inferior insecticides were Acephate 75 SP (60.37 %), Tolfenpyrad 15 EC (60.37 %), Fipronil 5 SC (53.70 %), Lambda Cyhalothrin 5 EC (53.33 %) and Cartap Hydrochloride 50 SP (46.30 %). Whereas, the percent mortality in each case of Thiacloprid 21.7 SC (3.33), Flubeniamide 19.92 + Thiacloprid 19.92 SC (3.33) and Azadirachtin 1 EC (6.67) was significantly at par with untreated control. The same was almost 7.04% for each of four other insecticides like Spirotetramat 15 OD, Chlorantraniliprole 18.5 SC, Flubendiamide 20 WG and Actamiprid 20 SP followed by more or less at par result with Imidacloprid 17.8 SL (10.37 %), Chlorfenapyr 10 SC (10.74 %), Spio tetramat 11.01 + Imidacloprid 11.01 SC (17.78%) and Emamectin Benzoate 5 SG (17.78 %). The next safer as well as significantly at par insecticides were Ethiprole 40 + Imidacloprid 40 WG (21.11 %) and Ethion 40 + Cypermethrin 5 EC (28.52 %).

Mortality (%) of R. marginatus at 2 DAT
The percent mortality of the tested predator against twenty two selected insecticides at 2 DAT varied significantly than untreated control. Comparing this mortality with 1 DAT, each insecticide resulted more fatality (%) to R. marginatus without considerable deviation its rank in most cases. The lowest at par mortality (7.41 %) was seen in Thiacloprid, Azadirachtin, Spirotetramat and Actamiprid. The next safer and statistically at par treatments were Imidacloprid (11.11 %), Chlorfenapyr (11.11 %), Chlorantraniliprole (14.81 %) and Flubeniamide (14.81 %). The recorded mortality (25.93 %) in Flubeniamide + Thiacloprid was significantly at par (33.33 %) for each of Spirotetramat + Imidacloprid, Ethiprole + Imidacloprid and Emamectin benzoate. Whereas, both Fipronil and Acephate 95 SG gave highest mortality of 96.30 %, which was followed by statistically at par 92.59 % for all of Chlorpyriphos, Quinalphos and Tolfenpyrad. The next inferior and significantly at par treatments were Acephate 75 WP (85.19 %), Bifenthrin (81.48 %), Ethion + Cypermethrin (74.07 %) and Lambda cyhalothrin (70.37 %) followed by Cartap hydrochloride (62.96 %).

Average mortality (%) of R. marginatus and toxicity class of insecticides
Considering IOBC protocol apropo average mortality, Chlorpyriphos 20 EC (85.74 %), Acephate 95 SG (85.56 %) and Quinalphos 25 EC (81.85 %) were grouped in toxicity class 3. Whereas, the descending sequence of insecticides belonging to toxicity class 2 was Bifenthrin 10 EC/Tolfenpyrad 15 EC (76.48 %) > Fipronil 5 SC (75.00 %) > Acephate 75 SP (72.78 %) > Lambda cyhalothrin 5 EC (68.85 %) > Cartap Hydrochloride 50 SP (54.63 %) > Ethion 40 + Cypermethrin 5 EC (51.30 %). However, toxicity class 1 included all other tested insecticides such as Thiacloprid 21.7 SC, Azadirachtin 1 EC, Spirotetramat 15 OD/Actamiprid 20 SP, Imidacloprid 17.8 SL, Chlorfenapyr 10 SC/Chlorantraniliprole 18.5 SC/Flubeniamide 20 WG, Flubeniamide 19.92 + Thiacloprid 19.92 SC, Spirotetramat 11.01 + Imidacloprid 11.01 SC/Emamectin Benzoate 5 SG and Ethiprole 40 + Imidacloprid 40 WG with ascending sequence of percent (%) average mortality follows as 5.37 < 7.04 < 7.22 < 10.74 < 10.93 < 14.63 < 25.56 < 27.22, respectively.

A very few information is available apropos insecticidal impact on predatory assassin bug. But it is sufficient against other predators such as lady beetles, Chrysoperla spp., spiders etc. Stadial body weight, fecundity and longevity of Rhynocoris marginatus was negatively affected by quinalphos and other organophosphate insecticides (George et al., 1998) [4]. Cypermethrin reduced the predatory efficiency in another species of assassin bug, Acanthaspis pedestris (Claver et al., 2003) [3]. Nimbicide (Azadirachtin 0.03 %) showed only 1.17 % nyphal (4th instar) mortality of Rhynocoris marginatus through contact toxicity (Sahayaraj and Selvaraj, 2003) [10]. The side effect of several organophosphate insecticides against coccinellid predators were proved by Staubli et al., 1984. In general, spiders were more sensitive to synthetic pyrethroids and organophosphates (Wakeil et al., 2013) [9]. The negligible detrimental field effects of natural enemies (lady beetles and spiders) were recorded in flubeniamide + thiacloprid (Patel, 2018) [11] and in spirotetramat + imidacloprid (Patel and Sarkar, 2019) [12]. Compatibility was noticed in chlorantraniliprole with biocontrol agents and considered it as less toxic insecticide ( Larson et al., 2012) [8]. Slightly harmful effect of chlorantraniliprole was noticed in laboratory on larva of Chrysoperla carnea (Sabry et al., 2014) [15]. The impact was moderately harmful on adult and larva of Cryptolaemus montrouzieri with neonicotinoids imidacloprid and acetamiprid (Halappa et al., 2013) [3]. Fipronil was harmful against larva of Chrysopa lacciperda under laboratory condition (Singh et al., 2010) [20]. Direct laboratory application of spirotetramat on larvae and adults of Cryptolaemus montrouzieri did not affect its survival, longevity, fecundity, egg hatching, and offspring survival (Planes et al., 2013) [14]. Coccinellids and spiders were unsafe during field application of bifenthrin, cartap hydrochloride and emamectin benzoate (Karthick et al., 2014) [7]. The broad-spectrum insecticide tolfenpyrad demonstrated to reduce populations of the key predator of thrips in pepper, Orius insidiosus (Srivastava et al., 2014) [21]. Acephate suppressed the population of coccinellids in rice ecosystem (Sharanappa et al., 2019) [18]. Whereas safety of chlorfenapyr was observed against coccinellids in onion crop (Yadav et al., 2020) [24]. Ethiprole resulted average toxicity against Cryptorhinus lividipennis, a predator of brown plant hopper in rice ( Nagalingam et al., 2009) [10]. All these previous findings are more or less in agreement with result as reported in this present research manuscript.

Conclusion
This may be the first report about slightly harmful effect caused by most of the taken new generation insecticides on the survival of one economically important insect predator Rhynocoris marginatus. Such findings must help to make decision for compatible use of insecticides with R. marginatus or other natural enemies in integrated pest management.

References
1. Abbott WS. Method for computing the effectiveness of an insecticide. Journal of Economic Entomology. 1925; 18:265-267
2. Ambrose DP. Assassin bugs. Science Publication, New Hampshire, USA, 1999, 337p.
3. Claver MA, Ravichandran B, Khan MM, Ambrose DP. Impact of cypermethrin on the functional response, predatory and mating behaviour of a non-target potential
biological control agent Acanthaspis pedestr (Sta’l) (Het., Reduviidae). Journal of Applied Entomology. 2003; 127:18-22
4. George PE, Ambrose DP. Effect of insecticides on the post-embryonic development in Rhynocoris marginatus (Fabricius) (Heteroptera: Reduviidae). Journal of Biological Control. 1998; 12(2):113-118
5. Halappa B, Awaknavar JS, Archana D. Toxicity of newer insecticides to lady bird beetle, Cryptolaemus montrouzieri Mulsant (Coccinellidae: Coleoptera) under laboratory condition. Journal of Entomological Research. 2013; 37(2):145-148.
6. Hassan SA. Guidelines for testing the effects of pesticides on beneficial organisms: Description of test methods. IOBC/WPRS Bulletin. 1992; 15(3):18-39
7. Kartick KS, Kandibane M, Kumar K. Safety of newer insecticides to natural enemies in the coastal rice ecosystem of Karaikal, U.T. of Puducherry. Journal of Biopesticides. 2014; 7(2):195-198.
8. Larson JL, Redmon CT, Potter DA. Comparative impact of an anthranilic diamide and other insecticidal chemistries on beneficial invertebrates and ecosystem services in turfgrass. Pest Management Science. 2012; 68(5):740-748
9. Wakeil NE, Nawal G, Ahmed S, Christa V. Side Effects of insecticides on natural enemies and possibility of their integration in plant protection strategies. Insecticides – Development of Safer and More Effective Technologies, 2013, 3-56p. DOI: 10.5772/54199
10. Nagalingam K, Bhohan V, Boomaithi N. Non-target effect of ethiprole 10 SC to predators of rice planthoppers. Madras Agriculture Journal. 2009; 96(1-6):208-212
11. Patel LC. Bioefficacy of a new crop combined insecticide, flubeniamide 24 + thiacloprid 24 SC against the caterpillars and sucking pest complex of blackgram. Indian Journal Plant Protection. 2018; 46(1):15-26.
12. Patel LC, Sarkar A. Efficacy of Spirotetramat 11.01 + Imidacloprid 11.01 SC against jassid, red mite and general predators in Tomato. Journal of Crop and Weed. 2019; 15(3):192-200
13. Paul AVP, Thayagarajan KS. Toxicity of pesticides to natural enemies of crop pests in India. In: David BV (ed) Pest Management and Pesticides: Indian Scenario, Narmrutha Publications, Madras, India, 1992, 158-177p.
14. Planes L, Catalan J, Tena A. Lethal and sublethal effects of spirotetramat on the mealybug destroyer, Cryptolaemus montrouzieri. Journal of Pest Science. 2013; 86:321-327
15. Sabry AH, Hassan KA, Rahman AA. Relative toxicity of some modern insecticides against the pink bollworm, Pectinophora gossypiella (Saunders) and their residues effects on some natural enemies. International Journal of Science, Environment and Technology. 2014; 3(2):481-491
16. Sahayaraj M, Selvaraj P. Side effects of selected biopesticides on redivuid predator Rhynocoris marginatus Fab. Entomologia Croaatia. 2003; 7(1-2):43-50
17. Sahayaraj K. Pest control mechanism of redivuids. Oxford Book Company, Jaipur, India, 2007, 120p.
18. Sharanappa, Kumar A, Sahu R, Khan HH. Effect of certain insecticide on natural enemies of rice stem borer, Sciropphaga incertulas (walker) on rice, Oryza sativa L. Journal of Entomology and Zoological Studies. 2019; 7(1):1100-1104
19. Sheikh AH. Studies on assassin bug (Reduviidae: Hemiptera: Insecta) fauna of Dumna Nature Park, Jabalpur, Madhya Pradesh. Journal of Zoological Studies. 2016; 3(5):83-86
20. Singh JP, Jaiswal AK, Monobrullah M, Bhattacharya A. Effect of selected pesticides on larval mortality of the neuropteran predator, Chrysopa lactipeda Kimmins of the lac insect, Kerria lactea (Kerr). Journal of Asia-Pacific Entomology. 2010; 13:69-72.
21. Srivastava M, Funderburk J, Olson S, Demirozer O, Reitz S. Impacts on natural enemies and competitor thrips of insecticides against the western flower thrips (Thysanoptera: Thripidae) in fruiting vegetables. Florida Entomology. 2014; 97(2):337-348
22. Staubli A, Hachler M, Antonin P, Mittaz C. Tests de nocivite de divers pesticides envers les enemies natural des principaux ravageurs de poiriers en suisse romande. Revue Suisse Viticulture, Arboriculture, Horticulture. 1984; 16(5):279-286
23. Wahengbam J, Raut AM, Mandal SK, Banu AN. Efficacy of new generation insecticides against Trichogramma chilonis Ishii and Trichogramma pretiosum Riley. Journal of Entomology and Zoological Studies. 2018; 6(1):1361-1365
24. Yadav D, Khinchik SK, Sharma P, Jangir H. Bio-efficacy of insecticides against Thrps tabaci on Onion and adverse effect on natural enemy. Ann Plant Protection Science. 2020; 28(1):12-14