ISSN: 1023-1072 (Print), ISSN: 2663-7863 (Online)

Pak. J. Agri., Agril. Engg., Vet. Sci., 2019, 35 (1): 29-33

IN-VITRO STUDY OF SUB-LETHAL EFFECT OF NEW CHEMISTRY INSECTICIDES ON THE ADULT *CHRYSOPERLA CARNEA* (STEPHENS)

Q. A. Soomro[1], R. Sultana[2], R. Muhammad[1], M. Sohail[3] and N. H. Khuhro[1]

[1]Plant Protection Division, Nuclear Institute of Agriculture, Tandojam, Pakistan
[2]Department of Zoology, University of Sindh, Jamshoro, Pakistan
[3]Department of Entomology, University College of Agriculture,
University of Sargodha, Pakistan

ABSTRACT

Four new chemistry insecticides *viz.* Bifenthrin (Talstar® 10% EC, FMC), Acetamiprid (Acelan®,20% EC, FMC), Imidacloprid (Imidacloprid®,25% EC, FMC) and Diafenthiuron (Polo®,100% EC, Syngenta Company) were evaluated against *Chrysoperla carnea*. Different concentrations (1.25, 2.5, 5, 7.5 and 10 µl/ml) of each insecticide were made in distilled water by serial dilutions tested to determine the sub-lethal concentration dose LC_{50} against adult's *C. carnea* under laboratory conditions. Topical bioassay was performed against adult *C. carnea*. Adulticidal activity of insecticide in term of LC_{50} and LC_{90} with confidential interval was evaluated. The LC_{50} values of Acetamiprid, Bifenthrin, Imidacloprid and Diafenthiuron for adults *C. carnea* were 31.3, 96.1, 2.3 and 30.5 µl/ml, respectively. Toxicity of the tested insecticides to *C. carnea* form most to least toxic was Imidacloprid > Diafenthiuron > Acetamiprid > Bifenthrin. The 95% confidence intervals of Acetamiprid, Bifenthrin and Diafenthiuron overlapped, suggesting no significant difference in the toxicities of these three insecticides to the adult *C. carnea*. The adults were most sensitive to Imidacloprid and required low concentration (2.3 ± 0.25 µl/ml) to cause 50% mortality of the targeted adults compared to rest of the insecticide. Bifenthrin was found to be most tolerant and require high concentration to acquire LC_{50} that is 96.1± 28.6 µl/ml. The log concentration under directly proportional to the probability of adult *C. carnea* mortality. Increase in log concentration of Acetamiprid (0.894) resulted increase in probability (3.66). The decrease in the log concentration (0.854) of Bifenthrin decreased the (3.31) probability of mortality. Similarly the log concentration related to probability of mortality with the increase of log concentration (2.453) of Imidacloprid increased the probability (4.12). While the proportion of decreased log concentration of Polo (1.206) decreased the probability (3.120). The finding of this study proved that the above tested insecticides are harmful to adult of *C. carnea.* Generaly Bifenthrin causes less damage and may be included in the Integrated Pest Management (IPM) program with fairly adverse residual effect on bio-control agents.

Keywords: adult mortality, *Chrysoperla carnea,* insecticides, sub-lethal concentration

INTRODUCTION[1]

Chrysoperla carnea (Stephen) commonly known as green lacewing is an important natural bio-control agent, belongs to the family Chrysopidae, orders Neuroptera. Its agricultural importance lies due to its carnivorous nature. The larvae are important predators, especially to control aphids. Some are terrestrial feeders on jassids, psyllids, aphids, coccids, mites, etc; they are very effective in pest management and very useful in reduction of pest population (Hydorn and Whitcomb, 1979; Legaspi *et al.*, 1994; Michaud, 2001). Insect pest and natural enemies are physiologically similar; therefore insecticides cause death in both groups (Croft, 1990). Generally, predators and parasitoids are more sensitive to pesticides than the target pests, adverse impact of insecticides on predators can be decreased/ controlled through timing of insecticide application, choice of insecticide and dosage (Galvan *et al.*, 2005). Three different new chemistry insecticides viz. spinosad, tebufenzide and azadirachtin have been documented for low effects against eggs, pupae and adults of *C. carnea* and reported that only Azadirachtin caused a slight reduction in the number of pupae and adults production

Corresponding author: soomroqadeer77@yahoo.com

(Medina *et al.*, 2001). Another new insecticides viz; Emamectin Benzoate, Thiocarb and Methomyl were investigated against all stages of *C. carnea* to determine the sub lethal effects and reported that Emamectin benzoate was relatively safer to all stages of *C. carnea* (Sechser *et al.*, 2003). Another study was carried out on development of new compound insecticide such as Imidacloprid, Oxamyl, and Cyfluthrin, with reduced environmental persistence and low mammalian and avian toxicity but a fairly broad spectrum insecticidal activity (Harris, 2000). Therefore, present research was carried out to investigate sub lethal (residual) effect of insecticides used to control sucking insect pests damage in Bt as well as conventional cotton crop cultivation using laboratory reared adult of *C. carnea*. This study would be helpful to determine the insecticide resistance natural enemies and enhance the releasing efficiency during cotton season.

MATERIALS AND METHODS

Rearing of *C. carnea*

A colony of adult *C. carnea* was reared in bio-control Laboratory, Plant Protection Division, Nuclear Institute of Agriculture. Adult insects were kept in plastic cages (24.5 x 24.5 x 24.5 cm in size). The mass reared culture was maintained at 25±2°C with relative humidity 60±5% and photoperiod of 16:8 (L: D). The fronts of rearing cages were covered with plastic nylon net for aeration and provision of an artificial diet (consisting of 4 g brewer's yeast, 2 g honey, 5 g sugar and 20 ml water) to adults on plastic net with the help of camel hair brush on daily basis (Vogt *et al.*, 2000*;* Mansoor *et al.*, 2017). The tops of rearing cages were capped/ covered with black muslin cloth for egg laying, eggs deposited on black muslin cloth were shaved daily using a safety razor and kept for producing laboratory culture. The newly hatched larvae of *C carnea* were fed *with Sitotroga cerealella* eggs inside the black muslin cloth

Insecticides formulation

The four new chemistry commercial insecticides *viz.* Bifenthrin (Talstar® 10% EC, FMC) Aceta-miprid (Acelan®, 20% EC, FMC), Imidacloprid (Imidachloprid®, 25% EC, FMC) and Diafenthiuron (Polo®, 100% EC , Syngenta) were used for the evaluation of their effects on predator population. Five different concentrations (1.25, 2.5, 5, 7.5 and 10 µl/ml) were prepared in distilled water and evaluated to determine the LC_{50} for adults of *C. carnea*. All insecticides were dissolved in acetone to prepare stock solutions.

Bioassay methods

The two days old *C. carnea* adults were collected from culture maintained at 25±2°C with 60% R. H. under laboratory conditions. About 15 adults of *C. carnea* were selected for each insecticide. A drop of 1µ of each prepared concentration of insecticides was applied directly on the abdominal sterna of adults *C. carnea* with Arnold microaplicator type LV 65 (Burkard UR). The treated adults were shifted separately in four liter glass jars (14 cm diameter X 23 cm heights). These adults were fed with (brewer yeast, 4 g, sugar 5 g, honey,1 g and distilled water 20 ml) adult artificial diet used for rearing of *C. carnea* in the laboratory. The experiment was replicated three times and observation was recorded on the basis of *C. carnea* adult mortality after 24 hour of treatment.

Data analysis

Data were analyzed by probit analysis (Finney, 1971) by using the Maximum Likelihood Program (POLO-PC, LeOra Software and Berkeley, California). To determine the median lethal concentration (LC_{50}) values, their 95% confidence intervals (CI) ranges and slope ± standard error (SE). Percentage mortality was calculated in Microsoft Excel spreadsheet and corrected by Abbot's formula (Abbott, 1925).

RESULTS

The present research work was carried out to evaluate safer insecticides against the adults *C. carnea*. Mortality of adults predator caused by above mentioned insecticides were observed after 24 hours at different concentrations. Topical bioassay was performed against adult *C. carnea*. Adulticidal activity of insecticide in terms of LC_{50} and LC_{90} with confidential interval are summarized in Table 1. The toxicities of the insecticide evaluated are reported graphically in Figure 1, 2, 3 and 4. The LC_{50} values of Acetamiprid, Bifenthrin, Imidacloprid and Diafenthiuron for adult's *C. carnea* were 31.3, 96.1, 2.3 and 30.5 µl/ml, respectively. Toxicity of the test insecticides to *C. carnea* form most to least toxic was Imidachloprid > Diafenthiuron > Acetamiprid > Bifenthrin. The 95% confidence intervals of Acetamiprid, Bifenthrin and Diafenthiuron overlapped, suggesting no significance difference in the toxicities of these three insecticides to the adult *C. carnea*. The adults were most sensitive to Imidacloprid and

required low concentration (2.3±0.25 µl/ml) to cause 50% mortality of targeted adults compared to rest of the insecticide. Bifenthrin was found most tolerant and require high concentration to acquire LC_{50} that is 96.1± 28.6 µl/ml.

Table 1. LC_{50} at 24 hours for sub-lethal effect on *C. carnea* adults

Insecticides	*N*	Slope	LC_{50} (95% C I)	LC_{90} (95% C I)
Acetamiprid	225	0.82± 0.2	31.3 ± 5.8 (11.3- 86.1)	875.2±72.3 (318.2-2407.5)
Bifenthrin	225	0.89 ±0.3	96.1± 28.6 (28.8- 320.6)	3190.3±651.6 (956.6-≥ 1000)
Imidacloprid	225	0.93±0.086	2.3 ± 0.25 (1.5- 3.5)	7.6±2.35 (5.2-11.3)
Diafenthiuron	225	0.51 ±0.18	30.5 ± 9.39 (13.1- 71.2)	331.1 ±78.6 (141.9-772.3)

n= Number of *C. carnea* adults per treatment.

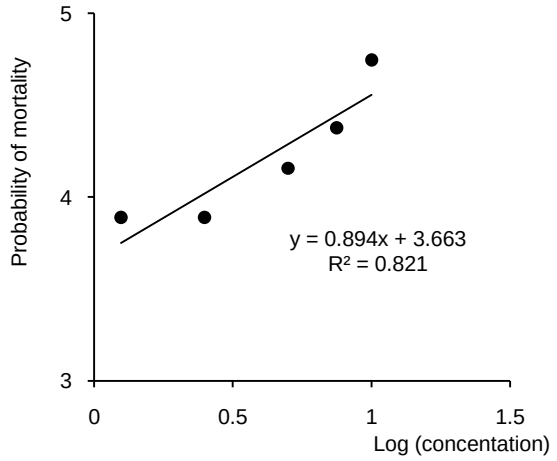

Figure 1. Response line graph of Acetamiprid. The concentration response line of each population was drawn using probit linear model y = αx + β in which α and β are the slope and intercept, respectively. x is the log-transformation concentration (µl/ml). y is the probability of mortality.

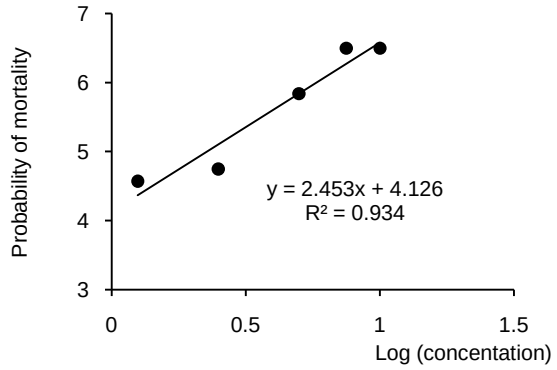

Figure 2. Response line graph of Bifenthrin. The concentration response line of each population was drawn using probit linear model y = αx + β in which α and β are the slope and intercept, respectively. x is the log-transformation concentration (µl/ml). y is the probability of mortality.

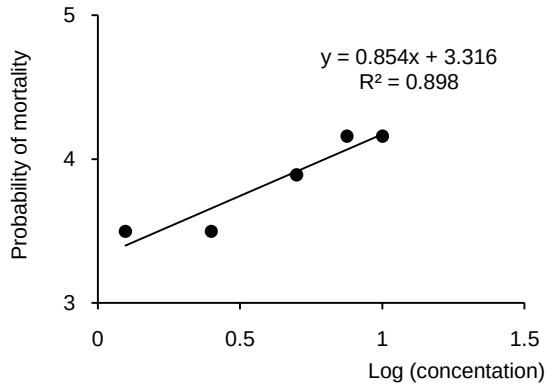

Figure 3. Response line graph of Imidacloprid. The concentration response line of each population was drawn using probit linear model y = αx + β in which α and β are the slope and intercept, respectively. x is the log-transformation concentration (µl/ml). y is the probability of mortality

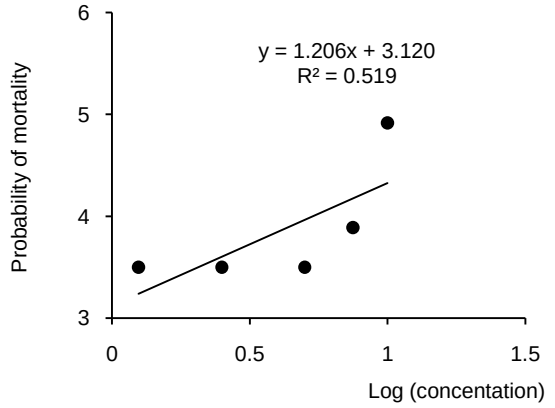

Figure 4. Response line graph of Diafenthiuron. The concentration response line of each population was drawn using probit linear model y = αx + β in which α and β are the slope and intercept, respectively. x is the log-transformation concentration (µl/ml). y is the probability of mortality

The log concentration was directly proportional to the probability of mortality. Increase in log concentration of Acetamiprid also increased the probability (Figure 1). Decreasing in log concentration of Bifenthrin also decreased the probability of mortality (Figure 2). Similarly, the log concentration related to the probability of mortality with the increase of log concentration of Imidacloprid increased the probability (Figure 3). While the proportion of decrease logs concentration of Diafenthiuren decreases the probability (Figure 4). The finding of this study proved that above tested insecticides showed harmful effect to adult of *C. carnea* but Bifenthrin caused least damage, may be included in the Integrated Pest Management (IPM) programs with fairly adverse residual effect on bio-control agents.

DISCUSSION

Integrated pest management program put emphasis on using selective and compatible pesticides for the conservation of insect predators and parasites (Vogt, 1994; Khan *et al.*, 2015). In this study four insecticides i.e. Bifenthrin, Acetamiprid, Imidacloprid and Diafenthiuron were used to evaluate their effect on the predator. Five different concentrations (1.25, 2.5, 5, 7.5 and 10 µl/ml) were prepared in distilled water. Results of this study revealed that minimum mortality was observed at highest LC_{50} and 95% confidence intervals with Bifenthrin (96.1± 28.6 and 28.8-320.6 µl/ml to adult's *C. carnea*) after 24 hours whereas, maximum morality was observed at minimum LC_{50} concentration and 95% confidence intervals (CI) with Imidacloprid (2.3±0.25 (1.5-3.5) µl/ml) to adult's *C. carnea* after 24 hrs interval. Similar results have also been reported by other workers. on sub-lethal effects of different insecticides against eggs, larvae and adult stages of *C. carnea* who found that Imidacloprid causes highest mortality against adults of *C. carnea* than eggs and larval stage (Preetha *et al.*, 2009). Related to this study an investigation was carried out on new chemistry insecticide Bifenthrin micro-greenhouse and semi field conditions and reported that Bifenthrin was moderately toxic to adults of *C. carnea* (Bustamante *et al.*, 1999). But difference may be due to methods and exposure conditions as our experiment was conducted under laboratory conditions. Our study also proved that LC_{50} concentration of a Bifenthrin insecticide was much safer than other insecticides, followed by Diafenthiuron. Similar, results have also been documented on residual toxicity of different insecticides Priority®, included Talent®, Actara®, Polo®, Ascort®, Confidor® and Pyramid® who's toxicity persists for less than seven days whereas residual toxicity of Polo was safer for adults of *C. carne*a among all tested insecticides (Asrar *et al.*, 2015). The residual toxicity of Diafenthiuron, Buprofezin, Thiodicarb, Imidacloprid, Carbosulfan, Methamidophos, Acetamiprid and Thiamethoxam against various stages of *C. carnea* are reported against adults of this predator (Nasreen *et al.*, 2005).

CONCLUSION

Four new chemistry insecticides viz; Bifenthrin, Acetamiprid, Imidacloprid and Diafenthiuren at different concentrations (1.25, 2.5, 5, 7.5 and 10 µl/ml) were tested to determine its LC_{50} dose against adults of *C. carnea*. All above tested insecticides showed toxic effect on adult *C. carnea*. But Bifenthrin and Diafenthiuren on the basis of their highest LC_{50} values remained relatively safer to the adults of *C. carnea* than the rest of other two insecticides. Therefore, it is concluded that these safer insecticides (Bifenthrin and Diafenthiuren) can be included in the future IPM program by keeping in view the stages of bio-control agents without any adverse residual effect

ACKNOWLEDGEMENT

This study was part of the Ph.D. dissertation research of first author. We acknowledge to Director (NIA), Head Plant Protection Division and Dr. Usman Asif, Junior Scientist, Nuclear Institute of Agriculture, Tandojam for their technical help and support.

REFERENCES

Abbott, W. 1925. A method of computing the effectiveness of an insecticide. Journal of Economic Entomology, 18: 265-267.

Asrar, M., A. Ghafoor and K. Zia. 2015. Laboratory bioassay for determination of residual toxicity of different insecticides against two predators, *Chrysoperla carnea* (Chrysopidae: Neuroptera) and *Coccinella septempunctata* (Coccinellidae: Coleoptera). Pakistan Entomologist, 3: 33-38.

Bustamante, M., A. Sabillon, C. Velasquez, J. Ordonez and F. Baquedano. 1999. Susceptibility of natural enemies of pests of agriculture to commonly applied insecticides in Honduras. Chanei Press Compamy.

Croft, B. A. 1990. Arthropod biological control agents and pesticides. John Wiley and Sons Inc.

Finney, D. J. 1971. Probit Analysis: 3rd Ed. Cambridge University Press.

Galvan, T., R. Koch and W. Hutchison. 2005. Toxicity of commonly used insecticides in sweet corn and soybean to multicolored Asian lady beetle Coleoptera:Coccinellidae). Journal of Economic Entomology, 98: 780-789.

Harris, J. 2000. Chemical pesticide markets, health risks and residues, Vol 1. CABI.

Khan, S. Z., F. Ullah, S. Khan, M. A. Khan and M. A. Khan. 2015. Residual effect of insecticides against different stages of green lacewing, *Chrysoperla carnea* (Neuroptera: Chrysopidae). Journal of Entomology and Zoology Studies, 3: 114-119.

Legaspi, J., R. Carruthers and D. Nordlund. 1994. Life-history of *Chrysoperla rufilabris* (Neuroptera: Chrysopidae) provided sweet potato whitefly *Bemisia tabaci* (Homoptera: Aleyrodidae) and other food. Biological Control, 4: 178-184.

Mansoor, M. M., A. B. M. Raza, N. Abbas, M. A. Aqueel and M. Afzal. 2017. Resistance of green lacewing, *Chrysoperla carnea* Stephens to nitenpyram: Cross-resistance patterns, mechanism, stability, and realized heritability. Pesticide Biochemistry and Physiology, 135: 59-63.

Medina, P., F. Budia, L. Tirry, G. Smagghe and E. Vinuela. 2001. Compatibility of spinosad, tebufenozide and azadirachtin with eggs and pupae of the predator *Chrysoperla carnea* (Stephens) under laboratory conditions. Biocontrol Science and Technology, 11: 597-610.

Michaud, J. 2001. Evaluation of green lacewings, Chrysoperla plorabunda (Fitch) (Neurop., Chrysopidae), for augmentative release against Toxoptera citricida (Hom., Aphididae) in citrus. Journal of Applied Entomology, 125: 383-388.

Nasreen, A., G. M. Cheema and M. Iqbal. 2005. Relative toxicity of different fungicides against larvae of green lacewing, Chrysoperla carnea (Chrysopidae: Neuroptera). South Pacific Studies, 26: 7-13.

Preetha, G., J. Stanley, T. Chandrasekaran and S. Kuttalam. 2009. Toxicity of imidacloprid and diafenthiuron to Chrysoperla carnea (Stephens) (Neuroptera: Chrysopidae) in the laboratory conditions. Journal of Plant Protection Research, 49: 290-296.

Sechser, B., S. Ayoub and N. Monuir. 2003. Selectivity of emamectin benzoate to predators of sucking pests on cotton. Journal of Plant Diseases and Protection, 184-194.

Vogt, H. 1994. Effects of pesticides on *Chrysoperla carnea* Steph.(Neuroptera: Chrysopidae) in the field and comparison with laboratory and semi-field results. IOBC, BARP and EPPO joint initiative (France), 27-44.

Vogt, H., F. Bigler, K. Brown, M. Candolfi, A. Travis, A. Ufer and E. Viñuela. 2000. Laboratory method to test effects of plant protection products on larvae of *Chrysoperla carnea* (Neuroptera: Chrysopidae). Journal of Economic Entomology, pp. 27-44.

(Accepted: January 31, 2019)