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Mortality of *Chrysoperla carnea* (Stephens) (Neuroptera: Chrysopidae) after exposure to some insecticides; laboratory studies

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Abstract

Eight Insecticides *viz.* diafenthiuron, buprofezin, thiodicarb, imidacloprid, carbosulfan, methamidophos, acetamiprid, thiamethoxam were tested for their toxicity against predator *Chrysoperla carnea* (Stephens) through leaf dip bioassay method under laboratory conditions. Insecticides were applied at three levels of concentration i.e., low (C1), recommended (C2), high (C3) in a completely randomized manner. Low (C1) and recommended (C2) concentrations of diafenthiuron and buprofezin were found harmless while high concentration of both insecticides was found slightly harmful after 24 hours exposure. Thiodicarb was harmless at lower concentration (C1) but slightly harmful at recommended (C2) and higher (C3) concentrations. Acetamiprid and thiamethoxam were moderately harmful at lower concentration (C1) whereas were toxic at recommended and higher concentrations. All insecticides, at all concentrations were found toxic after 48 hours except buprofezin and thiodicarb. Pupation rates were lowest (0.00 %) in the acetamiprid and highest (71.7 %) in the buprofezin treatment
Key words: C*hrysoperla carnea,* leaf dip bioassay, mortality, selective insecticides

Introduction

Presence and role of natural enemy in orchards, field crops and vegetables have been studied (Dean and Sterling 1992) to reduce the use of insecticides and environmental pollution. *Chrysoperla carnea* (Stephens) has received much attention as a potential biological control agent because of its geographical distribution (New 1975), its tolerance to some insecticide (Hassan *et al*. 1985) and its relative ease of mass production.

Chrysoperla carnea is predominant species of green lacewing. *C. carnea* has green cylindrical body, transparent wings with light green veins, long filiform antennae, golden eyes and stalked eggs that offer protection from predation (Pedigo 1989). Larvae of *C. carnea* is polyphagous, voracious feeder of cotton aphid, *Aphis gossypii* Glover; corn earworm, *Helicoverpa zea* (Boddie) (Lingren *et al.* 1968); Colorado potato beetle, *Leptinotarsa decemlineata* (Say) (Nordlund *et al*. 1991). Effectiveness of *C. carnea* as a biological control agent has been demonstrated in a field crops, orchards, green house (Hagley and Miles 1987).

In spite of all these preciousness *C. carnea* with many other beneficial organisms have almost eliminated from field due to frequent use of non- selective insecticides. Scientist all over the world are now condemning use of synthetic, organic insecticides.

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However these insecticides were effective when pests exceed economic thresholds level (ETL) and economic damaged occurred. But these insecticides have harmful effect on natural enemies. Now insecticides with novel mode of action have been developed to control pests of economic importance. These pesticides represent the beginning of new era in integrated pest management (IPM).

In the present study eight insecticides extensively used to control insect pest of cotton and were selected to test their toxicity against first instar larvae of *Chrysoperla carnea*, with purpose to screen out some selective insecticides that can be used in compatible with biological control and to evaluate its potential use in IPM programs in Pakistan.

Materials and Methods

Common names, trade names, and concentrations of various insecticides tested in the present study are given in Table 1. Formulated products of eight insecticides *viz.* diafenthiuron, buprofezin, thiodicarb, imidacloprid, carbosulfan, methamidophos, acetamiprid, thiamethoxam, were selected to determine their toxicity against neonate of *C. carnea* under laboratory conditions. Larvae of *C. carnea*, which were originated from field, were obtained from Insect Rearing Laboratory, University College of Agriculture, B. Z. University, Multan. Three concentrations of these insecticides i.e. C1, C2 and C3 representing lower dose, recommended dose and higher dose were prepared in tap water and used throughout the experimentations. The insecticides were classified according to the recommendation of the International Organization for Biological Control, West Palaearctic Regional Section (IOBC / WPRS) working group (Hassan 1989) as under:

Harmless (toxicity class 1) = less than 50 % mortality,
Slightly harmful (toxicity class 2) = 50-79 % mortality,
Moderately harmful (toxicity class 3) = 80-89 % mortality,
Harmful (toxicity class 4) = more than 90 % mortality.

Glass Petri plates (4.5 cm diameter) were used for experimentations. Cotton leaves were collected from the unsprayed field and washed with tap water. Cotton leaf disks of 4.5 cm diameter were cut and dipped into insecticide solution for 5 seconds and allowed to dry in open air. Untreated control was dipped in tap water only. Moistened filter was placed beneath leaf disks to avoid the desiccation of leaves in the Petri plates.

The experiment was conducted in a completely randomized design in three replicates. Twenty eggs per a replicate were used for each treatment. Gray eggs (three day old) of *C. carnea* were placed individually in Petri plates to avoid cannibalism. Eggs of *Sitotroga cerealella* Oliver were placed in Petri plates as a food for larvae of *C. carnea*. Eggs were kept at 27 ± 2 ºC and at 70 ± 5 % relative humidity. Mortality was observed 24 and 48 hours after hatching of *C. carnea*. Effect of insecticides was expressed as mortality of first instar larvae.

The larvae survived after exposure to insecticide moved to medium sized gelatin capsule along with 0.024 g eggs of *Sitotroga cerealella*. After completion of larval development, pupae in the capsules were kept in Petri plates for adult emergence. Rates of pupation and adult emergence were recorded.

Results and Discussion

Mortalities of *C. carnea* larvae 24 and 48 hours after exposure to three concentrations of eight insecticides under laboratory conditions are presented in Table 2. Low and recommended concentration (C1 and C2) of diafenthiuron and buprofezin were found harmless and caused less then 50 % mortality, while higher concentration (C3) and of both insecticides were found slightly harmful and caused 61 and 58 % mortality after 24 hours. Both chemicals were remained slightly harmful after 48 hours exposure with the exception that diafenthiuron caused more then 90 % mortality in higher concentration (C3). Abdelgader (2000) reported harmful effects of diafenthiuron on predators. Hassan *et al.* (1994) reported that buprofezin was harmless to *C. carnea*. Erkilic and Ygnn (1997) found that buprofezin has no or very limited detrimental effects on natural enemies. The higher concentrations of buprofezin are proved to have detrimental effects on *C. carnea* as compared to lower concentration.

Thiodicarb at low concentration (C1) was harmless after 24 hours, while recommended and higher concentrations (C2 and C3) were proved slightly harmful after 24 and 48 hours exposure respectively. McCutcheon and Durant (1993) evaluated toxicity of some insecticides against predaceous arthropods and reported that thiodicarb was tolerated by most of the predators.

All concentrations (C1, C2, C3) of imidacloprid, carbosulfan and methamidophos were found harmful after 24 and 48 hours exposure (Table 2). Badawy and Arnaouty (1999) also reported that mortalities at first, second and third instar larvae of *C. carnea* against insecticides belonged to classes' organophosphorous and carbamates. They reported that first and second instar larvae of *C. carnea* were most susceptible against organophosphate and carbamates.

Table 1. Insecticides with their commercial names, groups and formulation.

Treat-ments	*n*	Insecticides	Groups	Formulation	TQP/ ha	Concentration (%)		
						C1	C2	C3
T1	60	diafenthiuron (Polo)	Thiourea	500 SC	625 ml	0.25	0.375	0.5
T2	60	buprofezin (Sitara)	IGR's	25 % WP	1500gm	0.406	0.469	0.531
T3	60	thiodicarb (Larvin)	Carbamates	80 DF	1000gm	0.8	1.0	1.2
T4	60	imidacloprid (Confidor)	Chloronicotinyl	200 SL	625 ml	0.088	0.133	0.178
T5	60	carbosulfan (Advantage)	Carbamates	20 EC	1250 ml	0.25	0.3	0.35
T6	60	methamidophos (Tamaron)	Organophosphate	60 % SC	1200 ml	0.75	0.9	1.05
T7	60	acetamiprid (Raja)	Chloronicotinyl	20 % SL	375 ml	0.05	0.1	0.15
T8	60	thiamethoxam (Actara)	Chloronicotinyl	25 WG	60 gm	0.013	0.019	0.025
T9	60	Water (Control)						

Data belonging to larval mortality of *C. carnea* reveals that lower concentrations (C1) of acetamiprid and thiamethoxam caused 88.3 and 86.7 % mortality respectively and found moderately harmful after 24 hours and harmful after 48 hours exposure (Table 2). Recommended and higher concentrations (C2 and C3) of both insecticides were found harmful after 24 and 48 of exposure. Lawson *et al*. (1999) reported that thiamethoxam is classified as slightly harmful to beneficial insects and harmless to predatory mites. They further stated that it is often applied to the soil, which allows thiamethoxam to systematically protect the plant without contacting beneficial species, which remain on the plant surface. Therefore, flexibility in the application of thiamethoxam with limited leaf surface residues result in excellent pest control without disrupting natural enemies. But in our experiment thiamethoxam was toxic; it might be due to direct contact of C. *carnea* with insecticide. No mortality was observed in T9 control.

Duffie *et al*. (1998) demonstrated the survival of predaceous arthropods on cotton during 1996 and 1997 in growing seasons after insecticides spray. Insecticide classes included representatives from the following: Insect Growth Regulator (IGR), Carbamates, Pyrethroid, Chloronictinyl, and Organophosphate. The IGR had low toxicity while carbamates were moderately toxic to the predaceous arthropods. While, chloronicotinyl and organophosphate classes were the most toxic causing dramatic reductions in predator numbers.

Table 2. Mortality of neonate larvae of *Chrysoperla carnea* after exposure to different concentration of some insecticides.

Treatments	% Mortality after 24 (hrs)			% Mortality after 48 (hrs)			Toxicity Class (24hrs)			Toxicity Class (48hrs)		
	C1	C2	C3	C1	C2	C3	C1	C2	C3	C1	C2	C3
T1=diafenthiuron (Polo)	28.3	48.3	61.67	60	75	95	1	1	2	2	2	4
T2=buprofezin (Sitara)	20.3	38.3	58.3	28.3	51.6	65	1	1	2	1	2	2
T3=thiodicarb (Larvin)	40	53.36	61.67	61.67	61.67	65	1	2	2	2	2	2
T4=imidacloprid (Confidor)	98.3	100	98.3	100	-	100	4	4	4	4		4
T5=carbosulfan (Advantage)	100	100	100	-	-	-	4	4	4	-	-	-
T6=methamidophos (Tamaron)	95	98.3	100	96.67	100	-	4	4	4	4	4	-
T7=acetamiprid (Raja)	88.3	100	90	91.6	-	98.3	3	4	4	4	-	4
T8=thiamethoxam (Actara)	86.67	96.67	93.3	100	100	100	3	4	4	4	4	4
T9=Water (Control)	0	0	0	0	0	0	1	1	1	1	1	1

Table 3. Pupation rates and Adult emergence rates of *C. carnea* treated with different insecticides.

Treatments	*n*	Pupation Rate (%)			Adult Emergence Rate (%)		
		C1	C2	C3	C1	C2	C3
T1=diafenthiuron (Polo)	60	48.4	25.0	5.0	41.7	11.4	3.4
T2=buprofezin (Sitara)	60	71.7	48.4	45.0	65.0	46.7	40.0
T3=thiodicarb (Larvin)	60	38.4	36.0	35.0	35.0	31.7	33.4
T6=methamidophos (Tameron)	60	3.4	0.0	0.0	2.0	0.0	0.0
T7=acetamiprid (Raja)	60	9.0	0.0	2.0	6.7	0.0	1.0
T9=Water (Control)	60	100.0	100.0	100.0	98.4	96.7	98.4

Treatments T4, T5 and T8 were deleted as 100 % larval mortality after 48 hrs.

Pupation and adult emergence rates from treated larvae are given in Table 3. All larvae developed into pupae in T9. In the next pupation rate 71.7 % larvae were pupated in T2. None of the larvae succeeded to pupate in treatment T4, T5 and T8. Pupation rate decreased with the increase in insecticides concentration. Adult emergence rates from pupa are ranged from 96.7 to 98.4 in control. In treatments T1, T2, T3, T6 and T7 emergence rate were 41.7, 65.0, 35.0, 2.0 and 6.7 respectively. No effect of insecticides was recorded on adult emergence rate in treatments of lower concentration (C1).

A plant protection product (PPP) was considered harmless if mortality is less than 50 % of the larvae treated in initial laboratory test (Hassan 1989) and no further test in semi field and field condition will recommended. According to general agreement when PPP proved harmless in initial laboratory test for a particular beneficial organism is most likely to be harmless to the same organism in the field. Further testing (semi field and field condition) is necessary when a pesticide is found to be harmful that it caused more than 90 % mortality to a beneficial organism in initial laboratory toxicity test.

However, the effect of insecticides on a particular natural enemy involves numerous biotic and abiotic factors. Therefore it would be regrettable to exclude toxic compounds without looking for their specific uses. Selection of a suitable insecticide in an IPM programs not depends only on its toxicity level to beneficial insects but also on its efficacy against the target pest, its weathering and persistency.

It was concluded that insecticides v*iz*., thiamethoxam, acetamiprid, methamidophos, carbosulfan and imidacloprid, were found toxic to *C. carnea* larvae, and therefore recommended for semifield and field tests. It was also observed that once *C. carnea* larvae tolerated the insecticide exposure, they could pupate and adults emerge successfully.

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