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Residual effect of insecticides against different stages of green lacewing, *Chrysoperla Carnea* (Neuroptera: Chrysopidae)

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Abstract
With a view about the importance of *Chrysoperla carnea* as a predator in the management of various pests, the basic studies on the residual effect of different insecticides against all stages of *C. carnea* were conducted. Four insecticides belonging to different classes, including one botanical extract (Neem oil), were used in the experiment. The results showed that among the candidate insecticides, Emamectin benzoate proved to be the best one with significantly lower residual effect against egg, larva, pupa and adult of *C. carnea* (50%, 32.5%, 45%, 59.5% mortality) respectively. Spinosad followed Emamectin benzoate in residual toxicity against all stages of *C. carnea* (52.5%, 55%, 50%, 85% mortality) respectively. The results further revealed that Neem oil against egg and pupa (65% and 62.5% mortality) and Steward against larva and adult (55% and 85% mortality) respectively showed high residual effect. Thus, the results suggest that the Emamectin benzoate can be included in the Integrated Pest Management (IPM) Program without any adverse residual effect on bio-control agents used in an IPM.

Keywords: *Chrysoperla carnea*, Insecticides, Residual effect.

1. Introduction
Green lacewing, *Chrysoperla carnea* (Stephens) is a polyphagous predator that is released for pest control in greenhouses and is also very common in many agricultural systems. This species is a powerful agent in biological control programs because of an expanded geographical distribution, high compatibility to different systems, high searching ability and an easy way to rear [6]. *C. carnea* larvae are extremely effective predators in the protected or enclosed areas such as greenhouses, however, they may fail to survive and provide control when environmental conditions are too dry or too moist [15].
Mass releases of *C. carnea* in a Texas cotton field trial reduced bollworm infestation by 96%, although more recent studies show that *C. carnea* predation on other predators can disrupt cotton aphid control [19].
Insect pests cause up to 56% losses of crops in Pakistan [1]. Insecticides with broad toxicity to pests and their natural enemies are widely used in insect pest management. The overuse of insecticides can lead to the elimination of natural enemies and give rise to phenomena such as pest resurgence, occurrence of secondary pests, and selection of resistant insect populations. The integrated pest management (IPM) concept advocates both chemical and biological control in agricultural systems. However, biological control agents are difficult to maintain when pesticides are applied to control key pests because natural enemies are often more sensitive to insecticides as compared to the pests. To maintain natural enemies in IPM systems, predators and parasitoids should be resistant or tolerant to pesticides [1].
Insect natural enemies can develop resistance to insecticides in the field just as their hosts can, although they are perceived to be slow to develop pesticides resistance in either the laboratory or the field because of a combination of biological, ecological, and biochemical (lower detoxification capacity) factors. Insecticides also can affect the evolution of insecticide resistance in natural enemies by direct exposure to spray in the field, or indirectly by consumption insecticide-treated hosts. Knowledge of the evolution of resistance to insecticides in natural enemies in the field could enable the development of IPM programs that minimize the use of insecticides. Some predators or parasitoids have developed resistance in the field, and they can survive field rates of insecticides. For example, predatory phytoseiid mites have

developed a high level of resistance, and they can survive insecticide applications in the field. Some *Chrysoperla* species are known to exhibit tolerance or resistance to insecticides, which also makes the predator compatible with most IPM systems. However, generalizations about the tolerance of *C. carnea* to pesticides that are based on tests with single colonies or single populations may be inappropriate [1].

C. carnea has been reported to have some natural tolerance to several chemical insecticides although there may be considerable variation. So new pesticides have been introduced into market and are applied on wide scale. These new pesticides are effective against pests and are commonly used to be tested against biological control agents to evaluate their toxicity against beneficial insects like *C. carnea.* Keeping in view importance of the predator, studies were conducted to determine the residual effect of the selected insecticides against the various developmental stages of *C. carnea*.

2. Materials and Methods

Rearing of *Chrysoperla Carnea*

The adults of *C. carnea* were collected from the field and shifted to the laboratory of Plant Protection Department, The University of Agricultural Peshawar, Pakistan during summer 2009. This population was reared in the laboratory for >6 generations without exposure to insecticides. In the laboratory adults were kept at 25 ± 2 °C, 60 ± 5% RH, and a photoperiod of 18: 6 (L: D) hrs in a rearing cage (L: 36cm, W: 25cm, H: 35cm) with ventilation holes on both sides. Cage was covered with the removable lid on the top, lined inside with glossy paper for egg laying. Adult diet i.e. 80% milk, 10% honey, 5% yeast and 5% casein was offered on the paper cards glued to the back wall of cage. These cards were changed on alternate day. Eggs were collected daily in Petri dishes and were observed for larval emergence. Then each larva was placed in a separate vial having eggs of *Sitotroga cerealella* as a food and plugged with a cotton bud. After passing through different developmental stages, the larvae turned into cocoons. These cocoons were put in Petri dishes in an adult rearing cage for adult emergence. The adults were reared in a similar manner as mentioned above for further multiplication.

Screening of Insecticides

The candidate insecticides were tested against all the life stages (egg-adult) of *C. carnea* under laboratory condition (25± 2 ^{0}C temp and 60±5 RH) and photoperiod of 18: 6 (L: D). Stock solutions of formulated insecticides were prepared according to the maximum recommended dose in tap water. A control treatment of water application was included in each test to assess hatching and mortality of the test insect.

Preparation for the test

The candidate insecticides were sprayed on Roma variety of tomato (*Lycopersicon esculentum* Mill), at flowering stage up to run off level. Insecticide application was carried out with hand-sprayer (atomizer) which was thoroughly washed before use in each treatment. Leaves from each treatment were brought to laboratory at 0, 3, 7 and 14 days after application of spray. Experiment was conducted in completely randomized design (CRD) with 5 treatments, each repeated 10 times.

Test procedure

Leaves from each treatment brought to the laboratory were placed in Petri dishes (5cm dia.) so that its base was covered. One test insect (each immature stage) was placed in the center of the Petri dish. While five pairs of adults of test insect were released in a single treated jar in each treatment repeated five times. Care was taken in case of larvae not to escape from Petri dish by closing tightly with rubber bands. Residual assessment of the treatments was made till the end of the treated stage. The overall effects of the insecticides on test insect were judged on the basis of the following parameters.

Egg hatched

Number of eggs hatched was recorded after 24 hours interval. The average eggs hatched for each treatment were calculated by simple arithmetic mean (S. A. M).

Larval mortality

Number of larvae alive was recorded after 24 hours interval. Average for each treatment was calculated.

Adult emergence

Number of adults emerged from treated pupae were recorded after 24 hours interval by calculating average for each treatment.

Adult mortality

Number of adults alive was recorded after 24 hour interval by calculating average for each treatment.

1) Insect's mortality (for larval and adult) levels was determined on the basis of principles laid down by IOBC/WPRS working group [7]. A test was considered valid if natural mortality in control does not increase beyond 12.5 %.The insecticides will be categorized as; non-toxic (< 50 % mortality); slightly toxic (50-79 % mortality); moderately toxic (80-89 % mortality) and toxic (>90 % mortality).

2) In case of egg and pupal stages, % hatchability and % adult emergence were determined respectively.

Statistical Analysis

The experiment was conducted in completely randomized design with five treatments, replicated ten times. The data was assessed for analysis of variance and difference among the treatments by using computer software MSTATC and the means were separated by using the Duncan multiple range tests.

3. Results and Discussion

The data (Table I.) showed the residual effect of different insecticides on the egg hatching of *C. carnea*. No significant difference among the residual effect of different treatments on the egg hatching at zero day treatment application was recorded. Significantly lower egg hatching was observed on the leaves treated with Steward, Spinosad and Neem oil after third day treatments application. Slightly significant egg hatching was examined in treatment Emamectin benzoate. While significantly higher egg hatching was recorded in the control treatment and also significant increase in the residual effect of tested insecticides after different intervals (24, 48, 72 hours) was observed. No significant residual effect on egg hatching at seventh day treatment application was recorded among different treatments. While slightly significant increase in the residual effect was found after different intervals. After fourteen days treatments application, significantly higher egg hatching was recorded in the control treatment while lower but no significant residual effect among Emamectin benzoate, Steward, Spinosad and Neem oil was observed. However slight increase in the residual effect was examined at different intervals.

Our results regarding Spinosad and Steward are in conformity with Nasreen *et al*., (2004) [12] and Spinosad in conformity with Nasser (2008) [13] who observed that the above-mentioned insecticides showed less residual effect on egg hatchability and was considered harmless. However, our findings regarding Emamectin benzoate differed from Secheser *et al*., (2003) [17] who observed that Emamectin benzoate is relatively safe for the eggs of *C. carnea*. Also the reports of Senguttuvan *et al*., (2005)

Table 1: Residual effect of different insecticides on egg hatching of *Chrysoperla carnea*

	Treatments	Intervals (Hours)					Means	%Hatching
		24		48		72		
Zero Day	Emamectin Benzoate	1.200bcd		1.400abc		1.200bcd	1.267a	80
	Indoxacarb	1.000d		1.100cd		1.700a	1.267a	70
	Spinosad	1.400abc		1.200bcd		1.200bcd	1.267 a	70
	Neem Oil	1.000d		1.200 bcd		1.300bcd	1.167 a	50
	Control	1.500ab		1.400 abc		1.000 a	1.300 a	90
	Means	1.220a		1.260a		1.280a		
3rd Day	Emamectin Benzoate	1.000c		1.300b		1.200bc	1.167ab	50
	Indoxacarb	1.000c		1.200bc		1.200bc	1.133b	40
	Spinosad	1.000c		1.100bc		1.200bc	1.100b	30
	Neem Oil	1.000c		1.100bc		1.100bc	1.067b	20
	Control	1.000c		1.700a		1.300b	1.333a	80
	Means	1.000b		1.280a		1.200 a		
7th Day	Emamectin Benzoate	1.000d		1.000d		1.400abc	1.1333a	50
	Indoxacarb	1.000d		1.000d		1.500ab	1.167a	40
	Spinosad	1.000d		1.400abc		1.200bcd	1.200a	60
	Neem Oil	1.100cd		1.100cd		1.300bcd	1.167a	40
	Control	1.100cd		1.100cd		1.700a	1.300a	80
	Means	1.040b		1.120b		1.420a		
14th Day	Emamectin Benzoate	1.000b		1.200b		1.100b	1.100b	50
	Indoxacarb	1.000b		1.100b		1.200b	1.100b	20
	Spinosad	1.000b		1.000b		1.200b	1.067b	30
	Neem Oil	1.000b		1.100b		1.200b	1.100b	30
	Control	1.000b		1.600a		1.200b	1.267a	80
	Means	1.000b		1.200a		1.180a		

(LSD 0.5 for treatment at zero day, third day, seventh day and fourteenth day egg are 1.2099, 1.1724, 1.1798, and 1.1590 respectively.) Means followed by different letter(s) are significantly different from each other using LSD (P < 0.05) test.

[18] regarding Neem oil deviated from our results who observed that Neem oil allowed higher rate of egg hatchability and was considered non-toxic.

The data (Table II.) showed the residual effect of different insecticides against the larvae of *C. carnea*. Highly significant residual effect of Spinosad was examined on the mortality of larvae at zero day treatment application. While slightly low with no significant residual effect among Emamectin benzoate, Steward and Neem oil was recorded. Significantly very low larval mortality was observed in control treatment. Significant increase in the residual effect among different treatments after different intervals was found. Residual effect on larval mortality was significantly lower at third day after treatments application in control treatment. Moderately significant residual effect of Emamectin benzoate was recorded. While Spinosad and Neem oil showed slight residual effect and Steward exhibited high residual effect. Highly significant increase in the residual effect of tested insecticides was recorded after 48 hours interval. While slight increase in the residual effect was observed after 72 hours interval. No significant residual effect of the tested insecticides on the larval mortality after seventh day treatment application was found. However significant increase in residual effect was examined after different intervals. Steward showed highly significant residual effect on larval mortality after fourteenth day of treatments application. While moderate residual effect of the Neem oil was recorded and slight residual effect of the Spinosad was found and Emamectin benzoate showed low residual effect on larval mortality. Highly significant increase in the residual effect was recorded after different intervals.

Table 2: Residual effect of different insecticides on larval mortality of *Chrysoperla carnea*

	Treatments	Intervals (Hours)				Means	%Mortality
		24	**48**	**72**	**96**		
Zero Day	Emamectin Benzoate	1.000b	1.300a	1.000b	1.000b	1.075ab	30
	Indoxacarb	1.000b	1.300a	1.200ab	1.000b	1.125ab	50
	Spinosad	1.000b	1.300a	1.100ab	0.300a	1.175a	70
	Neem Oil	1.000b	1.000b	1.000b	1.300a	1.075ab	30
	Control	1.000b	1.000b	1.100ab	1.000b	1.025b	10
	Means	1.000b	1.180a	1.080ab	1.120a		
3rd Day	Emamectin Benzoate	1.000c	1.300ab	1.200bc	1.000c	1.125ab	50
	Indoxacarb	1.500a	1.200bc	1.200bc	1.000c	1.225a	90
	Spinosad	1.000c	1.200bc	1.000c	1.000c	1.050bc	20
	Neem Oil	1.000c	1.100bc	1.000c	1.000c	1.025bc	10
	Control	1.000c	1.000c	1.000c	1.000c	1.000c	10
	Means	1.100ab	1.160a	1.080ab	1.000b		
7th Day	Emamectin Benzoate	1.000c	1.300ab	1.200bc	1.000c	1.125ab	20
	Indoxacarb	1.500a	1.200bc	1.200bc	1.000c	1.225a	40
	Spinosad	1.000c	1.200bc	1.000c	1.000c	1.050bc	20
	Neem Oil	1.000c	1.100bc	1.000c	1.000c	1.025bc	10
	Control	1.000c	1.000c	1.000c	1.000c	1.000c	10
	Means	1.100ab	1.160a	1.080ab	1.000b		
	Emamectin Benzoate	1.000d	1.000d	1.000d	1.400a	1.100a	30

14th Day	Indoxacarb	1.000d		1.100cd	1.300ab	1.000d	1.100a	50
	Spinosad	1.000d		1.000d	1.200bc	1.000d	1.050a	50
	Neem Oil	1.000d		1.000d	1.100cd	1.000d	1.025a	90
	Control	1.000d		1.000d	1.100cd	1.00d	1.025a	10
	Means	1.000b		1.020b	1.140a	1.080ab		

(LSD 0.5 for treatment at zero day, third day, seventh day and fourteenth day larvae are 0.1224, 0.1134, 0.09767 and 0.1309 respectively). Means followed by different letter(s) are significantly different from each other using LSD (P < 0.05) test.

Our results regarding Steward are in concurrence with Dhawan (2000) [3] whose findings showed that it has slight residual toxicity against the *C. carnea* larvae. However, we differ from the observation made by Gulmohammadi *et al*., (2008) [6] regarding Steward which showed moderate toxicity against larval development. Our findings regarding Spinosad are in conformity with Dhawan (2000) [3] who reported no residual toxicity of these insecticides on *C. carnea* larvae. However, Ferreira (2006) [5] reported the same results on *C. externa* regarding Emamectin benzoate and Spinosad. The findings of the Sechser *et al*., (2003) [17] are in conformity with our findings regarding Emamectin benzoate. Our results regarding the residual effect of Emamectin benzoate are also similar to that of Nohad (2005) [14] who in a laboratory experiment observed that the insecticide was harmless to *C. carnea* larvae after 48 hours even at an exaggerated concentration of 1000ppm. Our findings regarding Neem oil are in conformity with Aggarwal and Brar (2006) [2] and El-Wakeil *et al*., (2006) [4] who observed non residual toxicity of Neem oil to the larvae of *C. carnea*. Kaethner (1991) [8] observed that the application of AZT extract + Neem oil does not harm eggs, larvae or adults of *C. carnea* and *Coccinella septempunctata* which are in conformity with our reports regarding Neem oil.

The data (Table III.) showed the residual effect of different insecticides on the adult emergence from pupae of *C. carnea*. At zero day treatments application, Neem oil showed significantly lower adult emergence from pupae while slight residual effect of Emamectin benzoate, Steward and Spinosad was observed. Relatively higher adult emergence from pupae was examined in the control treatment. Significant increase in the residual effect of different treatments was recorded after different intervals. Neem oil showed highly significant residual effect on adult emergence at third day of the treatments application. While moderate residual effect of Emamectin, Steward and Spinosad was recorded. Higher adult emergence was observed in the control treatment. Significant increase in the residual effect of different treatments was examined after different intervals. Spinosad and Neem oil revealed to have higher residual effect on the adult emergence at seventh day of the treatments applications. While moderate residual effect was recorded in the Emamectin benzoate and Steward treatments. Significantly higher increase in the residual effect of the tested insecticides was observed after different intervals (72, 96, 120 hours). Significantly lower residual effect at fourteenth day treatments application was examined in Steward, Spinosad and Neem oil. While Emamectin benzoate showed moderate residual effect on the adult emergence. Higher significant emergence was recorded in control treatment. Significantly higher residual effect of all the treatments was observed only after 120 hours.

Table 3: Residual effect of different insecticides on adult emergence from the pupae of *Chrysoperla carnea*

	Treatments	**Intervals (Hours)**					**Means**	**%Emergence**
		24	**48**	**72**	**96**	**120**		**70**
Zero Day	Emamectin Benzoate	1.000e	1.000e	1.000e	1.100de	1.500ab	1.120ab	60
	Indoxacarb	1.000e	1.000e	1.000e	1.100de	1.400 bc	1.100ab	80
	Spinosad	1.000e	1.000e	1.000e	1.200cde	1.300bcd	1.100ab	50
	Neem Oil	1.000e	1.000e	1.000e	1.000e	1.20cde	1.040b	90
	Control	1.000e	1.000e	1.000e	1.20cde	1.700a	1.180a	
	Means	1.000c	1.000c	1.000c	1.120c	1.42a		
3rd Day	Emamectin Benzoate	1.000d	1.000d	1.000d	1.000d	1.500b	1.100ab	60
	Indoxacarb	1.000d	1.000d	1.000d	1.100d	1.500b	1.120a	60
	Spinosad	1.000d	1.000d	1.000d	1.200cd	1.400bc	1.120ab	60
	Neem Oil	1.000d	1.000d	1.000d	1.100d	1.200cd	1.060b	40
	Control	1.000d	1.000d	1.000d	1.000d	1.900a	1.180a	90
	Means	1.000b	1.000b	1.000b	1.080b	1.500a		
7th Day	Emamectin Benzoate	1.000d	1.000d	1.000d	1.200bc	1.200bc	1.080b	50
	Indoxacarb	1.000d	1.000d	1.000d	1.100cd	1.300b	1.080b	40
	Spinosad	1.000d	1.000d	1.100cd	1.000d	1.000d	1.020b	30
	Neem Oil	1.000d	1.000d	1.000d	1.100cd	1.100cd	1.040b	20
	Control	1.000d	1.000d	1.000d	1.000d	1.900a	1.180a	90
	Means	1.000b	1.000b	1.020b	1.080b	1.300a		
14th Day	Emamectin Benzoate	1.000d	1.000d	1.000d	1.000d	1.600b	1.120ab	60
	Indoxacarb	1.000d	1.000d	1.000d	1.000d	1.300c	1.060b	30
	Spinosad	1.000d	1.000d	1.000d	1.000d	1.300c	1.060b	30
	Neem Oil	1.000d	1.000d	1.000d	1.000d	1.300c	1.060b	40
	Control	1.000d	1.000d	1.000d	1.000d	1.900a	1.180a	90
	Means	1.000b	1.000b	1.000b	1.000b	1.480a		

(LSD 0.5 for treatment at zero day, third day, seventh day and fourteenth day pupae are 1.1043, 1.09573, 1.08267 and 1.08172 respectively). Means followed by different letter(s) are significantly different from each other using LSD (P < 0.05) test.

Our results regarding Emamectin benzoates are in conformity with Secheser *et al*., (2003) [17] who concluded that the insecticide was harmless to *C. carnea* eggs and pupae irrespective of concentrations or method of treatments. The findings of Medina *et al*. (2001) [11] regarding Spinosad and Neem oil against eggs and pupae of the predator *Chrysoperla*

*carnea (*Stephens) deviated from our results. The observation made by Dhawan (2000) [3] are confirmed to some extent in our study, particularly in case of Steward that proved to be having slight to moderate residual toxicity against the *C.* carnea (68.8-84.8% mortality). However, the author partially differed from our observation regarding Spinosad.

The data (Table IV.) showed the residual effect of different insecticides on the adult mortality of *C. carnea*. Steward and Spinosad showed the higher residual effect on the adult mortality at zero day treatments application. Significantly moderate residual effect of the Emamectin benzoate and Neem oil on the adult mortality was recorded. Lower significant mortality of adult was found in the control treatment. Higher significant residual effect of all the treatments was examined after 24-hours interval while slight increase in residual effect of all treatments was recorded after consecutive intervals (48, 72, and 96, 120). Significantly higher residual effect of Emamectin benzoate, Steward and Spinosad on adult mortality at third day after treatments application was examined. Neem oil showed moderate residual effect on adult mortality and vary low adult mortality was found in control treatment. Significant increase in the residual effect of all treatments on adult mortality was recorded after different intervals. Significantly higher residual effect of Steward on adult mortality after seventh day of the treatments application was found followed by the Neem oil that showed moderate residual effect on adult mortality. However, Emamectin benzoate and Spinosad had significantly slight residual effect on the adult mortality. Significantly very low adult mortality was found in control treatment. Significant increase in the residual effect of all treatments was recorded after different intervals. Significantly higher residual effect of Steward on adult mortality was recorded after fourteenth day of the treatments application. Relatively moderate residual effect of Emamectin benzoate and Neem oil was observed on adult mortality. While Spinosad showed slight residual effect on adult mortality. Significantly very low adult mortality was recorded in control treatment. Significant increase in the residual effect of all treatments was examined after different intervals. While highly significant residual effect was found after 24 and 96 hours interval.

Table 4: Residual effect of different insecticides on adult mortality of *Chrysoperla carnea*

	Treatments	Intervals (Hours)					Means	%Mortality
		24	48	72	96	120		
Zero Day	Emamectin Benzoate	1.000f	2.600d	1.600def	2.600d	2.200df	2.000b	46
	Indoxacarb	7.200a	7.000def	2.200de	1.800def	1.000f	2.760a	90
	Spinosad	6.000b	1.600def	1.800def	1.800def	1.800def	2.600a	82
	Neem Oil	1.000f	1.000f	2.000def	1.000f	4.400c	1.880b	26
	Control	1.000f	1.000f	1.000f	1.200ef	1.400ef	1.120c	10
	Means	3.240a	1.560c	1.720bc	1.680c	2.160b		
3rd Day	Emamectin Benzoate	1.000e	2.200bcde	2.200bcde	3.000ab	3.600a	2.400a	70
	Indoxacarb	3.600a	1.600cd	2.800abc	2.400abcd	2.800abc	2.640a	82
	Spinosad	3.000ab	2.000bcde	3.000ab	2.000bcde	2.800abc	2.560a	60
	Neem Oil	1.000e	1.000e	1.400de	2.000bcde	3.200ab	1.720b	36
	Control	1.000e	1.000e	1.000e	1.400de	1.200de	1.120c	15
	Means	1.920c	1.560c	1.080bc	2.160b	2.720a		
7th Day	Emamectin Benzoate	1.000g	1.600efg	2.200cdefg	3.400bc	3.200bcd	2.280ab	64
	Indoxacarb	5.400a	2.200cdefg	1.600efg	2.800bcde	1.600efg	2.720a	86
	Spinosad	2.200cdefg	2.200cdefg	2.800bcde	3.400bc	3.400bc	2.520ab	74
	Neem Oil	1.000g	1.000g	2.000defg	2.600bcdef	3.600b	2.040b	54
	Control	1.000g	1.400fg	1.000g	1.400fg	1.000g	2.160c	10
	Means	2.120abc	1.680c	1.920bc	2.440ab	2.560a		
14th Day	Emamectin Benzoate	1.200fg	1.600defg	1.400efg	3.800b	2.200cdefg	2.040b	54
	Indoxacarb	5.400a	2.000cdefg	1.400efg	2.800bcd	1.800cdefg	2.680a	84
	Spinosad	2.600bcde	2.200cdefg	2.400cdef	3.000bc	2.200cdefg	2.480ab	74
	Neem Oil	1.000g	1.600defg	2.200cdefg	1.800cdefg	3.000bc	1.920b	46
	Control	1.000g	1.200fg	1.000g	2.200cdefg	1.000g	1.280c	10
	Means	2.24 0ab	1.720b	1.680b	2.720a	2.040b		

(LSD 0.5 for treatment at zero day, third day, seventh day and fourteenth day adult are 1.4788, 1.5406, 1.6188 and 1.5917 respectively). Means followed by different letter(s) are significantly different from each other using LSD (P < 0.05) test.

Our results regarding Spinosad are in accordance with Pilar *et al*., (2005) [16] Nasser (2008) [13] and Medina *et al*., (2001, 2003a) [11, 9] who reported Spinosad slightly harmful to adult stage. Our findings regarding Neem oil agree with El-Wakeil *et al*., (2006) [4] whose observation proved that the chemical was harmless to adults of *C. carnea*. However, we differ with the findings of Medina *et al*., (2001, 2003b) [11, 10] regarding the residual toxicity of Neem oil against adults of *C. carnea.* We also differ from the findings of Sechser *et al*., (2003) [17] regarding Emamectin benzoate. Our results regarding Steward residual toxicity towards *C. carnea* are parallel to the findings of Dhawan (2000) [3] who observed the moderate residual toxicity of Steward against the adults of *C. carnea*, however the author partially differed from our observation regarding Spinosad.

4. Conclusion

On the basis of observed results, it is recommended that the use of Emamectin benzoate in the IPM Programs should be encouraged. While Neem oil and Steward, due to its deleterious effect on *Chrysoperla carnea* must be dropped out from the IPM tool kit. Spinosad needs further investigations for its compatibility with the biological control agent.

5. References

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