RESPONSE OF VARIOUS LACEWING SPECIES (NEUROPTERA: CHRYSOPIDAE) TO SOME PYRETHROID INSECTICIDES

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Abstract

The number of beneficial organisms is considerable. When characterising their pesticide susceptibility, it would be too demanding to measure the response of each species to the different preparations. Thus, IOBC WPRS Working Group "Pesticides and Beneficial Organisms" decided to choose some of natural enemies for the pesticide testing which are relevant to the crop on which the particular pesticide is to be used. However, this practice left without solution the saving of other not assessed beneficial organisms. In Europe and all over the world from the family Chrysopidae Chrysoperla carnea sensu lato has been used as a testing agent. Regarding the other lacewing species, toxicological information is scarce and the applicability of data gained on Ch carnea to other chrysopids has not been examined.

Present study assessed the impact of some synthetic pyrethroids on adult Ch. carnea, Chrysopa perla and Chrysopa formosa. Results showed that the insecticide tolerance of these species can differ significantly from each other, that is Ch. carnea's role as a model species for the family Chrysopidae from point of view of pesticide tolerance is questionable.

Key words: Neuroptera, Chrysopidae, *Chrysoperla carnea* s.l., *Chrysopa perla*, *Chrysopa formosa,* pesticide, side-effects.

INTRODUCTION

The amount of beneficial organisms is significant. When characterising their pesticide tolerance, it would be too demanding to measure the response of each species to the different preparations. Regarding IOBC WPRS (International Organisation for Biological Control of Noxious Animals and Plants, West Palaearctic Regional Section) Working Group "Pesticides and Beneficial Organisms" there was an agreement that the natural enemy chosen for the pesticide testing should be relevant to the crop on which the pesticide in question is to be used. From the family Chrysopidae *Chrysoperla carnea* (Stephens, 1836) sensu lato has been selected as a general predator (Hassan *et al.* 1985) because this species is a good candidate for use in IPM programs. It is distributed worldwide, has a wide host plant and prey range (Principi and Canard, 1984), can be easily mass cultured (Ridgway *et al.* 1970), manipulated using food sprays (Hagen and Tassen, 1970) and overwintering boxes (McEwen et al. 1999), and pesticide tolerant populations have been identified (Pree *et al.* 1989). However, the searchers of Working Group "Pesticides and Beneficial Organisms" did not examined other lacewing species or dealt with whether the toxicological values measured on *Ch. carnea* can be applied or not to other lacewing species. This question has not been investigated moreover not even asked.

Ch. carnea s.l. is among the best tested beneficials regarding their pesticide tolerance. Side-effects of more than 150 formulated pesticide products have been assessed only on their larvae and pupae (Bigler and Waldburger, 1994; Rumpf *et al.* 1997), and also the number of preparations tested on the adults can achieve about 100 (Bartlett, 1964; Wilkinson *et al.*1975; Suter, 1978; Grafton-Cardwell and Hoy, 1985; Bozsik, 1991).

Regarding the assessing of side-effects of genetically modified crops to natural enemies also *Ch. carnea* s.l. is the most thoroughly investigated test organism (Lővei and Arpaia, 2005).

In Europe besides *Ch. carnea* s.l. there are many lacewing species having considerable role in controlling pest populations. *Chrysopa perla* (Linnaeus, 1758) and *Chrysopa formosa* Brauer, 1850 are both often occurring, wide spread species. In contrast to the glyciphagous and pollinivorous adult feeding habit of *Ch. carnea* s.l., adults of these species are omnivorous and favour living pray mainly aphids (Principi and Canard, 1984; Bozsik, 2000). Thus, also their adults are active natural enemies. In addition, both species are eurytopic, prefer the shrub belt (Aspöck *et al.* (1980), and can be found mainly in orchards, gardens, at forest edges and along hedgerows. Considering the species chosen for present investigation, there is little information about their insecticide tolerance. Some studies were prepared in the 60's and 80's of the last century so mainly side-effects of organophosphate insecticides were tested on them (Tables 1 and 2.).

The aim of this study is to assess the insecticide susceptibility of *Ch. carnea* s.l., *Ch. perla* and *Ch. formosa* to two insecticides (synthetic pyrethroids) in order to compare them and to drew consequences whether pesticide susceptibility data of *Ch. carnea* are similar or different to those of the other two species.

Table 1.

Pesticide susceptibility of different stages of *Chrysopa formosa*

Pesticide	Egg	Larvae	Pupa	Adult	References
deltamethrin	-	-	-	3[a]	Bozsik (1986) not published
diazinon	3	2	3	4	Babrikova (1980) in Bigler (1984)
ethiophencarb	2	1	2	4	Babrikova (1980) in Bigler (1984)
fenithrothion	-	3			Kowalska and Szczepanska (1971) in Bigler (1984)
phosalone	1	1	2	3	Babrikova (1980) in Bigler (1984)
pirimicarb	2	4	4	2	Babrikova (1980) in Bigler (1984)
tetrachlorvinphos	1	1	1	4	Babrikova (1980) in Bigler (1984)
trichlorphon	2	2	4	4	Babrikova (1980) in Bigler (1984)

[a]: categories of Bigler (1984)
0 = no effect, 1 = low effect (< 40 % M = mortality), 2 = moderate effect (41-70 % M),
3 = high effect (71-90 % M), 4 = extremely high effect (91-100 % M).

Table 2.

Pesticide susceptibility of different stages of *Chrysopa perla*

Pesticide	Egg	Larvae	Pupa	Adult	References
malathion	3[a]	-	-	-	Zeleny (1965 in Bigler, 1984)
sumithion	2	-	-	-	Zeleny (1965 in Bigler, 1984)
thiomethon	1	-	-	-	Zeleny (1965 in Bigler, 1984)

Abbreviations see at Table 1.

MATERIAL AND METHODS

Ch. carnea s. l. adults were collected in 1992 in an uncultivated area (hedge-row along the experimental area of the Agricultural University of Gödöllő) in Gödöllő (30 km north-east of Budapest) and adult *Ch. perla* and *Ch. formosa* specimens were caught in 1998 and 1999 in the same hedge in Gödöllő. Captures were obtained by sweeping net. Individuals were identified according to the descriptions of Aspöck *et al.* (1980). Table 3 contains the list of chemicals and also the concentrations examined

Leaves of *Philadelphus coronarius* Linnaeus, 1758 were immersed in the test solutions then air dried for about one hour. The leaf was placed into a glass Petri dish (10 cm diameter) and a small plastic dish with food (1:1:1 mixture of honey, yeast and pollen; in case of *Ch. formosa* and *Ch. perla* also living aphids – *Aphis spiraephaga* Müller, 1961) and a little ball of wet cotton were put on it. 10 adults were placed in each dish. There were two dishes per concentration. The test animals remained in the dish until a stable mortality resulted. The number of paralyzed or dead individuals was recorded after 1, 5, 10, 20, 40 minutes, 1, 2, 4, hours, 1, 2,...days. Data were analyzed by probit analysis with a program that incorporates Abbot's (1925) correction for natural mortality. All tests were conducted in the laboratory at 22-25 °C, 40-60 % RH, and under a L16:D8 photoperiode.

Table 3.

Chemicals and their concentrations used in screening

Preparation	Registered concentrations %	Test concentrations %
Ambush C (100 mg/l cypermethrin)	0.04	0.0004-0.004-0.01-0.04
Karate 5 EC (5 % lambda-cyhalothrin)	0.03-0.05	0.0002-0.0006-0.0024-0.0075-0.012 0.015-0.03-0.06

RESULTS

Results are presented in Tables 4 and 5. Regarding the LC_{50} values the data of *Ch. carnea* are higher than the values of *Ch. perla* or *Ch. formosa* that is *Ch. carnea* s.l. is more tolerant to the preparations than the two other species, and also these values differed significantly from those of *Ch. perla* and *Ch. formosa*. LT_{50} values seem to be differing similarly, and the impact of the registered concentration (mortality%) of lambda-cyhalothrin is more detrimental for both species than for *Ch. carnea* s.l. When analyzing some categories used for evaluation of pesticide side-effects on natural enemies, a similar tendency can be observed (Table 5).

Table 4.

Impact of two insecticides on adult *Chrysoperla carnea* s.l., *Chrysopa perla* and *Chysopa formosa* (surface contact effect)

Insecticides	*Ch. carnea* s.l. LC_{50} LT_{50} M%	*Ch. perla* LC_{50} LT_{50} M%	*Ch. formosa* LC_{50} LT_{50} M%
Ambush C	0.0098 6.47 91.1 (0.0064-0.0153)[a]	0.0034 4.22 87.6 (0.0000-0.0061)	Not tested
Karate 5 EC	0.0558 7.45 39.4 (0.0244-0.4145)	0.0063 3.20 98.8 (0.0037-0.0085)	0.0032 1.06 92.0 NC

LC_{50} = lethal concentration 50% in % of the preparation, a = fiducial limits of 95%,
NC = fiducial limits are not to be counted
LT_{50} = lethal time 50% of the registered concentration in days
M% = mortality% of the registered concentration

Table 5.

Susceptibility of adult *Chrysoperla carnea* s.l., *Chrysopa perla* and *Chysopa formosa* to the chemicals examined

Preparation	*Ch. carnea* s.l.			*Ch. perla*			*Ch. formosa*		
	A	B	C	A	B	C	A	B	C
Ambush C	L	3	4	M	3	3	-	-	-
Karate 5 EC	L	1	1	M	3	4	M	3	4

A: categories of Bartlett (1964)

0 = no kill, L = LT 50 > 100 hours, M = LT 50 > 24 hours and < 100 hours, H = LT 50 < 24 hours.

B: categories of the IOBC/WPRS-Working Group "Pesticides and Beneficial Organisms" (Hassan, 1985)

1 = harmless (< 50 % mortality = M), 2 = slightly harmful (50-79 % M), 3 = moderately harmful (80-99 % M), 4 = harmful (>99 % M).

C: categories of Bigler (1984)

0 = no effect, 1 = low effect (< 40 % M), 2 = moderate effect (41-70 % M), 3 = high effect (71-90 % M), 4 = extremely high effect (91-100 % M).

DISCUSSION

It is difficult to compare the susceptibility of *Ch. formosa* and *Ch. perla* with that of *Ch. carnea* s.l. on the basis of former testing because of the scarcity of data. Only a few studies tried to assess their tolerance but the preparations or active ingredients used in present work have not been tested former. Thus, comparisons cannot be made.

Considering the present results it seems that *Ch. perla* and *Ch. formosa*, both are less tolerant to synthetic pyrethroids than *Ch. carnea* s.l.. The reason for this phenomenon can be the continuous exposure of *Ch. carnea* s.l. individuals at fields treated with insecticides (Pree *et al.* 1989). *Ch. carnea* s.l. larvae have been living mainly in agricultural areas where pesticides have been used regularly (Bigler, 1984; Deutsch *et al.* 2005). Taking into account the difference observed between the susceptibility of *Ch. carnea* s.l. and *Ch. perla* and *Ch. formosa* it is but hazardous to apply values representing pesticide side-effects on common green lacewing to other lacewing species. The only way to get information about their pesticide tolerance in order to save the natural populations of these species, is their introducing into pesticide side-effect testing and then considering the measured values.

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