Relative Toxicity of Different Fungicides Against Larvae of Green Lacewing, *Chrysoperla carnea* (Chrysopidae: Neuroptera)

Abida Nasreen[1], Ghulam Mustafa Cheema[1] and Muhammad Iqbal[2]

1: University College of Agriculture, Bahauddin Zakariya University, Multan, Pakistan
2: Department of Agricultural Extension, Punjab, Pakistan

Abstract

Laboratory experiments were carried out to study the toxicity level of some fungicides against *Chrysoperla carnea* (Stephens) larvae. Recommended concentrations of Carbendazim 50 WP, Mancozeb 80 WP and Ridomil 68 WP and water (control) were applied through leaf dip method in Petri plates. *C. carnea* larvae of 1st, 2nd and 3rd instars were exposed to these fungicides treated leaves in Petri plates. Results indicated that all fungicides were safer to all larval stages of *C. carnea* after 24, 48 and 72 hrs. Highest mortality was observed in Ridomil treated larvae. It caused 4.44 % mortality of 1st and 3rd instars larvae after 24 and 72 hrs. Maximum pupation rate (89.32 %) was recorded in Mancozeb treated 2nd instar larvae. Adult emergence was 95-97 % in all treatments. The longevity of adults of *C. carnea* was nearly similar (49-50 days) for all treatments. The maximum fecundity (950 eggs) was observed in adults, where larvae were treated with water, whereas minimum (897 eggs) was found in treatment where larvae were exposed to Ridomil. Fungicides had no toxic effect on larvae of *C. carnea* at any stage and found safer according to IOBC classification for measuring toxicity.
Key words: *Chrysoperla carnea*, fungicides, toxicity

Introduction

Green lacewing, *Chrysoperla carnea* (Stephens), is a voracious and generalist predator of many soft bodies insect pests and has worldwide distributions (Geetha and Swamiappan 1998, New 1975, Zeleny 1984). The daily feeding potential of larvae is 100-120 eggs of lepidoteran pests (Gautam and Gupta 1998). Effectiveness of *C. carnea* as biological control agent has been demonstrated in field crops, orchards and in green houses (Hagley and Miles 1987). Conservation of natural fauna either through selective use of pesticides or by other means has been the main criteria for integrated plant protection. Many insecticides have been found moderately to very harmful to the larvae of *Chrysoperla carnea* in the field (Vogt 1994). Mathirajan and Regupathy (2002) in an experiment observed that test concentrations of thiamethoxam, imidacloprid and methyl-o-demeton had no adverse effects on egg hatchability and lower egg mortality of *C. carnea* as compared to water, whereas the larval mortality ranged from 10 to 48.7 %. Paulian (1998) tested the activity of 28 pesticides in the laboratory on *C. carnea*. He stated that insecto-fungicides mixtures, generally for cereal seed treatment such as Difenoconazol + Lindane, Tirametox 90 PTS, Tebuconazol + Lindane, Gamavit 85 PSu, Supercarb T 80 PSu, Procarb L, Trialin showed medium toxicity at usual rates, whereas

Received July 12, 2004
Accepted July 25, 2005

insecticides (Oleoekalux CE, Sintox 40 CE, Dimevur 52.5 Olerocarbetox, US 1 RV) were found toxic. GUVEN and GOVEN (2001) tested different pesticides on *C. carnea* in the laboratory including three fungicides and found that fenarimol, mancozeb+metalaxyl and micronized sulphur showed 45 %, 28 % and 16 % death rate, respectively. According to RIDGWAY and JONES (1968) and GEETHA and SWAMIAPPAN (1998), *C. carnea* can be well integrated in a pest management program that includes certain conventional or systemic insecticides as predaceous larvae are tolerant to insecticides. The intent of present studies was to evaluate the toxicity of different fungicides against different larval instars of green lacewing and subsequent effect of fungicides on pupation, adult longevity and fecundity of female under laboratory conditions.

Material and Methods

Experiments were conducted in *C. carnea* Rearing Laboratory of University College of Agriculture, Bahauddin Zakariya University, Multan. Field collected colony of *C. carnea* was cultured in the laboratory. The experiment was laid out in Randomized Complete Block Design with four treatments and three replications with 30 larvae in each replication. The treatments prepared at recommended dose were Carbendazim 50 WP (T_1, 800g/100 L of water), Ridomil MZ 68 WP (metalaxyl and mancozeb) (T_2, 200g/100 L of water), Mancozeb 80 WP (T_3, 120g/100 L of water) and water as control (T_4). All fungicides were broad spectrum and systemic with protective and curative action (Table 1).

Table 1. Trade name, common name, chemical class and rates of the pesticides used in this study.

Trade Name	Common Name	Group	Dose (a. i.) g/100 L	Recommended Dose g/100 L of water
Carbendazim 50 WP	Carbendazim	Benzimidazole	400	800
Ridomil MZ 68 WP	Metalaxyl and Mancozeb	Acylalanine and Alkylenebis	136	200
Mancozeb 80 WP	Mancozeb	Alkylenebis (dithiocarbamate)	96	120

The concentrations of tested fungicides were prepared in 100 ml of tap water. Healthy leaves of mango were cut into 2 cm diameter disc and dipped in the prepared chemicals for five seconds and placed on a sieve for 20 minutes to remove deposits of fungicides on leaves. The treated leaves were placed in Petri plate of 2 cm diameter and 0.5 cm depth. Larvae of each instar were placed individually in Petri plate. Processed eggs of Angoumois grain moth, *Sitotroga cerealella* were provided as larval food at 30 mg/larva. The tested larvae were kept under laboratory conditions (27 ± 2 °C and 60 ± 5 % relative humidity). The data concerning toxicity of fungicides were recorded as the

number of live larvae after 24, 48 and 72 hours. The live larvae were kept under laboratory conditions up to pupation. Number of pupae was recorded in each treatment. The overall effect of a test substance was judged on the basis of insect mortality levels.

Emergence rate, longevity of adults and fecundity of females were also studied. Ten pairs of adults from each treatment were transferred to cylindrical plastic jars of 21 cm diameter and 11cm depth. Semisolid artificial diet containing yeast, honey and water (1:1:0.5) streaked on a white chart paper strip of 22 cm length and 2.5 cm width and hanged inside the jars.

Results

The toxicity of tested fungicides was found very low against all instars of *C. carnea* larvae (Table 2). The effect of different fungicides was not significant ($P \geq 0.05$) on 1st instar larvae after 24, 48 and 72 hrs. The highest toxicity (4.44 %) was observed in the Ridomil treatment, whereas lowest (0 %) was recorded in control after 24 hrs. The IOBC toxicity class was remained "1" throughout all treatments in 1st instar. The influence of treatments including control was generally the same on 2nd and 3rd instar larvae of *C. carnea* as non-significant effect ($P \geq 0.05$) was noted after 24, 48 and 72 hrs. Daily mortality did not exceed 5.00 %. The IOBC toxicity class was remained 1 throughout all treatments also for 2nd and 3rd instars.

Table 2. Mortality of 1st, 2nd and 3rd instar larvae of *Chrysoperla carnea* caused by different fungicides.

Fungicides (Treatments)	Larval instar	*n*	Mortality (%) after			Toxicity class* after		
			24h	48h	72h	24h	48h	72h
Carbendazim (T1)	1st	90	3.3	5.6	6.7	1	1	1
	2nd	90	3.3	5.6	8.9	1	1	1
	3rd	90	1.1	4.4	7.8	1	1	1
Mancozeb (T2)	1st	90	2.2	2.2	4.4	1	1	1
	2nd	90	2.2	4.4	6.7	1	1	1
	3rd	90	2.2	4.4	7.8	1	1	1
Ridomil (T3)	1st	90	4.4	5.6	6.7	1	1	1
	2nd	90	2.2	3.3	6.7	1	1	1
	3rd	90	2.2	3.3	7.8	1	1	1
Water (T4, control)	1st	90	0	1.1	1.1	1	1	1
	2nd	90	3.3	4.4	5.6	1	1	1
	3rd	90	1.1	2.2	3.3	1	1	1

*Toxicity classes: 1= harmless, 2= slightly harmful, 3= moderately harmful, 4= harmful.

The highest (92 %) and the lowest pupation rate (81 %) were found in control and the Carbendazim treatments, respectively (Fig. 1). However, results were not significantly different ($P \geq 0.05$) in all treatments. Therefore there was no significant effect of fungicides

on pupation. Adult emergence rate was 95-97 % in all treatments (Table 3). The effect of fungicides on longevity of adults was not significant (P≥0.05). The highest longevity (50 days) was found in the Carbendazim treatment, whereas lowest (48 days) was found in the Ridomil (Table 3). The maximum fecundity (950 eggs) was observed in control, whereas minimum (897 eggs) was found in the Ridomil.

Table 3. Adult emergence rate, longevity and fecundity of *C. carnea* after exposure to some fungicides.

Fungicides (Treatments)	*N*	Adult emergence rate (%)	Longevity[1]	Fecundity[2]
Carbendazim (T1)	249	96.58	50.3 ± 0.72 *n.s.*	925.2 ± 38.02 *n.s.*
Mancozeb (T2)	253	97.04	49.5 ± 1.11 *n.s.*	907.0 ± 46.9 *n.s.*
Ridomil (T3)	251	94.53	47.6 ± 1.86 *n.s.*	897.1 ± 68.3 *n.s.*
Water (T4, control)	271	96.37	49.6 ± 1.28 *n.s.*	950.0 ± 60.5 *n.s.*

1: Longevity = Mean duration ± S.D. 2: Fecundity = Mean number/female ± S.D.
n.s.: Not significantly different between 4 treatments by One way ANOVA.

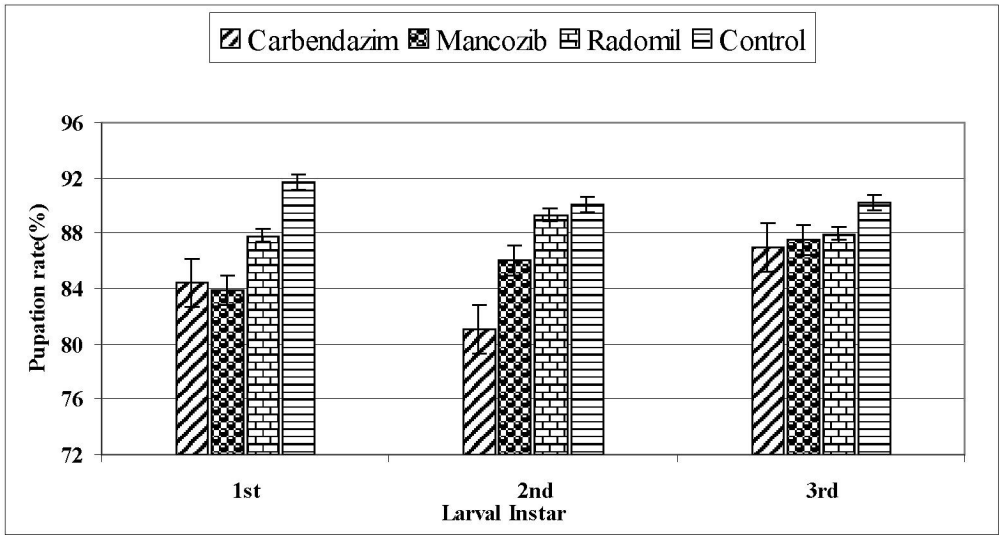

Fig. 1: Effect of different fungicides on pupation rate (%) of *Chrysoperla carnea*. Vertical bars indicate standard error. There is no significant effect among treatments (P≥ 0.05, one way ANOVA).

Discussion

The results were analyzed by IOBC/WRPS working group (HASSAN 1989) method as percent mortality was assigned a specific category. All the treatments were fallen in category "1" as all fungicides were found safer to all larval instars. Fungicides are sprayed for controlling fungal diseases on many vegetables, mango and citrus orchards. Previously, TODA and KASHIO (1997) tested 34 insecticides, six acaricides and nine fungicides and found that acaricides and fungicides showed no toxicity. In present studies, the applications of tested fungicides were found safer for all larval instars (1st, 2nd and 3rd). However, GUVEN and GOVEN (2001) found that fenarimol, mancozeb+metalaxyl and micronized sulphur showed 45 %, 28 % and 16 % death rate, respectively against *C. carnea* in the laboratory on larval mortality, whereas in our results it remained between 0 and 4.44 %. The recommended concentrations in the present studies had no lethal effect on the growth and development of the beneficial insect. The fungicides are mostly used in orchards, vegetables and other crops against fungal diseases. Effect of mixture of insecto-fungicides (Difenoconazol + Lindane, Tirametox 90 PTS, Tebuconazol + Lindane, Gamavit 85 PSu, Supercarb T 80 PSu, Procarb L, Trialin) showed medium toxicity at usual rates, whereas insecticides (Oleoekalux CE, Sintox 40 CE, Dimevur 52.5 Olerocarbetox, US 1 RV) were found toxic to *C. carnea* (PAULIAN 1998). Therefore, applying biological agents (*C. carnea*) with only fungicides will definitely helpful for integration of different pest controlling methods. It will help in keeping the population of predators unaffected.

Similarly, other parameters; pupation rate, adult emergence rate, longevity and fecundity also remained unaffected from fungicides. When there was no direct exposure of adults to fungicides, the indirect effect was minimal. Resultantly, emergence of adults was normal as found out by MORRISON (1977a, 1977b). The longevity of adult females fed on *Macrosiphum euphorbiae* during the larval stage was 46.16, with fecundity of 750.66 eggs/female. Females fed on *Trialeurodes vaporariorum* lived for 51.83 days and laid 818.16 eggs (YOLDAS 1994). TESFAYE and GAUTAM (2002) found that highest number of eggs/female (1245.2) was laid when adults were supplemented with baker's yeast granules plus 50% honey followed by baker's yeast granules plus castor pollen plus 50% honey (1069.2) and castor pollen plus 50% honey (450). The reproductive period of female was observed to reach up to 8, 9, 8 and 4 weeks when fed with baker's yeast granules plus castor pollen and 50% honey, baker's yeast granules plus 50% honey, castor pollen and 50%, honey and 50% honey, respectively. Therefore, differences of fecundity between these studies and ours did not depend on the effect of fungicides but depend on foods for the adult.

Knowledge of the effects of pesticides on biological control agents is required for the successful implementation of integrated pest management (IPM) programs (CABRERA *et al.* 2004). It was concluded that all the three fungicides have no toxic effect on larval, pupal as well as adult stage of *C. carnea* when applied at larval stage. The above-mentioned results suggest that these fungicides are safe to the predator (all stages) and can easily be manipulated in integrated pest management (IPM) programs.

References

BARTLETT, B. R. 1964. Toxicity of some pesticides to eggs, larvae and adults of common green lacewing, *Chrysopa carnea*. J. Econ. Entomol. 57(2): 366-369.

CABRERA, A. R., CLOYD, R. A. and ZABORSKI, E. R. 2004. Effects of Greenhouse Pesticides on the Soil-dwelling predatory mite *Stratiolaelaps scimitus* (Acari: Mesostigmata: Laelapidae) under laboratory conditions. J. Econ. Entomol. 97 (3): 793-799.

GAUTAM, R. D. and GUPTA, T. 1998. Potential of insect predators and parasitoids in vegetable ecosystem. *In*. D. Prasad and R. D. Gautam (eds.). Potential IPM tactics. Westvill Publishing House, New Delhi. pp. 77-81.

GEETHA, B. and SWAMIAPPAN, M. 1998. Improved adult rearing cages for the predator, *Chrysoperla carnea*. Madras Agric. J. 85 (5,6): 333-334.

GUVEN, B. and GOVEN, M. A. 2003. Side effects of pesticides used in cotton and vineyard areas of Aegean Region on the green lacewing, *Chrysoperla carnea* (Stephen) (Neuroptera: Chrysopidae) in the laboratory. Proc. IOBC/WPRS Working Group "Pesticides and Beneficial Organisms" at Avignon (France), 8-11 October, 2002. IOBC/WPRS Bull. 26 (5): 21-24.

HAGLEY, E. A. C. and MILES, N. 1987. Release of *Chrysoperla carnea* Stephen (Neuroptera: Chrysopidae) for control of *Tetranychus urticate* Koch (Acarina: Aphididae) on peach grown in a protected environment structure. Can. Entomol. 119(2): 205-206.

HASSAN, S. A. 1989. Testing methodology and the concepts of the IOBC/WPRS Working Group. *In*. P. C. Jepson (ed.). Pesticides and non-target invertebrates. Dorset, Wimborne. pp. 1-18.

MATHIRAJAN, V. G. and REGUPATHY, A. 2002. Effect of thiamethoxam 25 WG (Actara®) on *Chrysoperla carnea*. Ann. Pl. Prot. Sci. 10(2): 374 –375.

MORRISON, R. K. 1977a. A simplified larval rearing unit for the common green lacewing. Southwest Entomol. 2: 188-190.

MORRISON, R. K. 1977b. Developments in mass production of *Trichogramma* and *Chrysopa* spp. *In*. Proc. Beltwide Cotton Production Research Conference, National Cotton Council. pp. 149-151.

NEW, T. R. 1975. The biology of Chrysopidae and Hemerobiidae (Neuroptera) with reference to their use as biological agent: A review. Transactions of the Royal Entomol. Soc. London. 127: 115-140.

PAULIAN, M. 1998. Effect of some plant protection products on *Chrysoperla carnea* Stephens (Neuroptera: Chrysopidae). Analele Institutului de Cercetari pentru Cereale Protectia Plantelor. 29: 137-144.

RIDGWAY, R. L. and JONES, S. L. 1968. Field cage releases of *Chrysopa carnea* for suppression of population of the bollworm and the tobacco budworm on cotton. J. Econ. Entomol. 61(4): 892-898.

STEEL, R. G. D. and TORRIE, J. H. 1980. Multiple comparisons. *In*. Principles and procedures of statistics: A biometric approach. 2nd ed. McGraw-Hill, New York. pp. 172-194.

TESFAYE, A. and GAUTAM, R. D. 2002. Effect of adult food supplements on reproductive attributes and longevity of *Chrysoperla carnea* Stephens (Neuroptera: Chrysopidae).

Ann. Pl. Prot. Sci. 10(2): 198-201.

TODA, S. and KASHIO, T. 1997. Toxic effect of pesticides on the larvae of *Chrysoperla carnea*. Kyushu Pl. Prot. Res. 43: 101-105.

VOGT, H. 1994. Effects of pesticides on *Chrysoperla carnea* Stephen (Neuroptera: Chrysopidae) in the field and comparison with laboratory and semi-field results. IOBC/WPRS Bull. 17(10): 71-82.

YOLDAS, Z. 1994. Studies on the biology of *Chrysoperla carnea* (Stephens) (Neuroptera: Chrysopidae) feeding on two different preys. Turkiye III. Biyolojik Mucadele Kongresi Bildirileeri, 25-28 Ocak 1994, Ege Universitesi Ziraat Fakultesi, Bitki Koruma Bolumu, Izmir. pp. 375-380.

ZELENY, J. 1984. Chrysopidae occurrence in West Palaearctic temperate forests and derived biotopes. *In*. CANARD, M., SEMERIA, Y. and NEW, T. R. (eds.). Biology of Chrysopidae. Series Entomol. 27: 151-160.