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Evaluation of Toxicity of Different Pesticides to the Green lacewing, *Mallada boninensis* (Chrysopidae:Neuroptera)

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ABSTRACT

The green lacewing, *Mallada boninensis* (Okamoto) is an important predator of sucking insects like mealybugs, syrphids and psyllids. A total of 34 commercial pesticides (18 insecticides, 16 acaricides/fungicides) on the larvae and adults of *M. boninensis* was studied for their initial toxicity at field recommended concentrations. Larvae were less susceptible than the adults. Fenvalerate, endosulfan, methyl demeton and synthetic pyrethroids were less toxic to the larvae. None of the insecticides tested was safe to the adults of *M. boninensis*. But the fungicides proved harmless to both the larvae and adults. The insecticides which had shown high initial toxicity were further tested for their residual toxicity to both the stages. Insecticides like dichlorvos, methyl demeton, endosulfan and synthetic pyrethroids had low residual toxicity and hence could be incorporated into the integrated control programme.

KEY WORDS: Pesticides, *Mallada boninensis*, larvae, adults, toxicity

Selective insecticides to control the pests without adversely affecting important natural enemies are needed for integrated pest management programme. Testing the side effects of insecticides on beneficial organisms is therefore drawing increasing attention by research workers in different parts of the world (Hassan *et al.*, 1988). The effect of pesticides on many species of chrysopids had been studied in detail (Plap and Bull, 1978; Pree and Hagley, 1985; Mizell and Schiffahauer, 1990; Hassan *et al.*, 1991). Perusal of literature revealed that there were variations in the response to pesticides among different chrysopids. *Mallada boninensis* (Okamoto) had been reported to be an important predator of mealybugs (Mani and Krishnamoorty, 1990), aphids (Rao and Jagadish Chandra, 1985) and psyllids (Lee and Shin, 1982). Not much information on the effect of pesticides on *M. boninensis* is available. Only Brettell (1984) had tested a few chemicals against this species. The present study was carried out to get a comprehensive information on the toxicity of 34 pesticides to the larvae and adults of *M. boninensis*. The chemicals which were found to be toxic were tested further for their persistent toxicity to get information on the relative usefulness of the pesticides in the integrated control programme.

MATERIALS AND METHODS

M. boninensis was reared in the laboratory on the frozen eggs of rice moth, *Corcyra cephalonica* (Staint) as described by Krishnamoorthy and Nagarkatti (1981) for *Brynckochrysa* (= *Chrysopa*) *scelestes* (Banks). Laboratory-bred larvae and adults were used as test insects. All the studies were conducted at 28 ± 2°C and 60-70% RH.

A total of 34 pesticides comprising of 18 insecticides and 16 fungicides/acaricides were included in the present study. The insecticides with their trade names and recommended concentrations are given in Table 1.

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Formulated materials were diluted with water to get the desired concentration. Pesticides were sprayed separately on potted guava plants with hand compression sprayer. Leaves from treated plants were removed for exposure to the predator in glass vials (20 x 4 cm). Second instar larvae (3-5 days old) as suggested by Hassan et al. (1985) were introduced in the glass vials. Each replicate contained 10 such larvae in a glass vial and three replicates were maintained for each treatment. The treated leaf bit was introduced into the vial in which frozen eggs of rice moth were kept for larval feeding. Mouth of the vial was covered with a thin muslin cloth. Larval mortality was recorded at 1, 3, 6 and 25 h of exposure. Moribund larvae were considered as dead. Similarly, adults were exposed and fed with 50% honey solution and mortality was recorded.

Only insecticides which had shown initial toxicity were tested further for their residual toxicity to the predator. Leaves from treated plants were removed and exposed at time intervals until the chemicals became non-toxic to the predator.

Zero value in the mortality were converted into 0.01 and the data were transformed into corresponding angles (arcsin $\sqrt{\%}$) for statistical analysis. 'F' test was employed to analyse the differences in the mortality of the predator due to different treatments.

RESULTS AND DISCUSSION

The response of *M. boninensis* larvae to treatment with different pesticides varied from highly susceptible to highly tolerant (Table 1). Among the insecticides, fenvalerate appeared to be safe to the predatory larvae without causing any mortality even after 24 h of exposure. But the larvae of *M. boninensis* were found highly susceptible to fenthion which inflicted 100% mortlity within one hour of exposure and dichlorvos, methyl parathion, chlorpyriphos and quinalphos within three hours of exposure. Initially, there was no mortality with the chemicals like monocrotophos, malathion, phosphamidon and acephate, but they proved detrimental after 25 h of exposure. Predatory larvae were moderately tolerant to endosulfan, methyl demeton, cypermethrin, deltamethrin and fluvalinate causing 23.33 to 53.33% larval mortality. All the fungicides/acaricides *viz.*, dicofol 0.05%, metalaxyl + mancozeb 0.2%, fosetyl-A10.2%, mancozeb 0.2%, triadimefon 0.1%, chlorthalonyl 0.2%, triademorph 0.1%, dinocap 0.1%, captan 0.2%, thiophanate mithys 0.1%, sulphur 0.2%, copper oxychloride 0.3%, carbendazim 0.1%, ziram 0.2% and bordeoux mixture 0.1% were harmless to the larvae of *M. boninensis*.

Adult green lacewings were found highly susceptible to all the insecticides tested (Table 2). Methyl demeton, dichlorvos, methyl parathion, fenthion, quinalphos, fenvalerate, cypermethrin, phosphamidon, deltamethrin and fluvalinate caused 100% mortality of adults within one hour of exposure. The other insecticides were also equally toxic to the adults of *M.boninensis*. However, the adults were unaffected by any of the fungicides/acaricides included in the present study.

Residual toxicity of 16 insecticides to the second instar larvae of *M. boninensis* is presented in Table 3. Several of them like dimethoate, methyl demeton, quinalphos, methyl parathion, carbaryl, deltamethrin, acephate, fluvalinate and dichlorvos were found non- toxic to the predatory larvae one day post treatment. But the residual toxicity of malathion, cypermethrin and fenthion lasted for 14 days while the remaining insecticides were harmless on 7th day of treatment (Table 3). Residual toxicity of different insecticides to the adults of *M. boninensis* is presented in Table 4. Methyl demeton, fluvalinate and dichlorvos became less/non-toxic to the adults one day post treatment. But chemicals like chlorpyriphos and fenthion remained toxic upto one month (Table 4).

Table 1. Effect of certain insecticides on the larvae of *Mallada boninensis*

Treatments	Mortality of larvae (arcsin √%)			
	Hours after application			
	1	3	6	24
Endosulfan 0.07% (Thiodan 35 EC)	0.57	0.57	0.57	43.06
Methyl demeton 0.05% (Metasystox 25 EC)	0.57	0.57	0.57	41.13
Dimethoate 0.05% (Rogor 30 EC)	0.57	0.57	0.57	54.76
Monocrotophos 0.05% (Nuvacron 40 SC)	0.57	0.57	0.57	90.0
Dichlorvos 0.10% (Nuvacron 100 EC)	44.98	90.0	0.90	90.0
Methyl parathion 0.10% (Metacid 50 EC)	0.57	90.0	0.90	90.0
Carbaryl 0.10% (Sevin 50 WP)	0.57	0.57	0.57	90.0
Fenthion 0.10% (Lebaycid 1000)	0.57	90.0	0.90	90.0
Malathion 0.10% (Cythion 50 EC)	0.57	0.57	26.06	90.0
Quinalphos 0.05% (Ekalux 25 EC)	0.57	90.0	90.0	90.0
Fenvalerate 0.01% (Sumicidin 20 EC)	0.57	0.57	0.57	0.57
Cypermethrin 0.005% (Cymbush 25 EC)	0.57	0.57	0.57	28.77
Phosalone 0.07% (Zolone 35 EC)	0.57	0.57	0.57	61.20
Phosphamidon 0.10% (Dimecron 80 EC)	0.57	0.57	0.57	90.0
Acephate 0.10% (Orthene 75 SP)	0.57	0.57	0.57	90.0
Deltamethrin 0.01% (Decis 2.8 EC)	26.06	30.98	30.98	46.90
Chlorpyriphos 0.05% (Dursban 25 EC)	44.98	90.0	90.0	90.0
Fluvalinate 0.01% (Maverik 25 EC)	28.33	28.77	33.20	33.20

	SEM	Level of Significance	C.D. (P = 0.05)
Treatments (A)	0.55	0.01	1.54
Hours after application (B)	0.25	0.01	0.71
Interaction (A x B)	1.11	0.01	3.08

Synthetic pyrethroids like fenvalerate and deltamethrin were less toxic to *M. boninensis* adults 7 days after treatment.

Chrysopid larvae are generally more tolerant to pesticides than other groups of beneficial organisms. (Vanden Bosch *et al.*, 1956; Lingren and Ridgway, 1967; Krishnamoorthy, 1985; Grafton-Cardwell and Hoy, 1985; Mizzel and Schiffhauer, 1990). In the present study also, larvae of *M. boninensis* were less susceptible than the adults. Fen-

Table 2. Effect of certain insecticides on the adults of *M. boninensis*

Treatments	Mortality of larvae (arcsin √%)			
	Hours after application			
	1	3	6	24
Endosulfan	0.57	90.0	90.0	90.0
Methyl demeton	90.0	90.0	90.0	90.0
Dimethoate	0.57	0.57	23.85	90.0
Monocrotophos	0.57	90.0	90.0	90.0
Dichlorvos	90.0	90.0	90.0	90.0
Methyl parathion	90.0	90.0	90.0	90.0
Carbaryl	23.85	90.0	90.0	90.0
Fenthion	90.0	90.0	90.0	90.0
Malathion	0.57	90.0	90.0	90.0
Quinalphos	90.0	90.0	90.0	90.0
Fenvalerate	90.0	90.0	90.0	90.0
Cypermethrin	90.0	90.0	90.0	90.0
Phosalone	0.57	37.21	61.20	90.0
Phosphamidon	90.0	90.0	90.0	90.0
Acephate	0.57	0.57	90.0	90.0
Deltamethrin	90.0	90.0	90.0	90.0
Chlorpyriphos	90.0	90.0	90.0	90.0
Fluvalinate	90.0	90.0	90.0	90.0

	SEM	Level of Significance	C.D. (P = 0.05)
Treatments (A)	0.28	0.01	0.79
Hours after application (B)	0.12	0.01	0.36
Interaction (A x B)	0.56	0.01	1.58

valerate appeared to be non-toxic to the larval stage. Low toxicity of fenvalerate to *Chrysoperla rufilabris* (Burmeister) (Mizzel and Schiffhauer, 1990), *Chrysoperla carnea* (Steph.) (Singh and Varma 1986) and *Chrysopa sinica* (Za and Zheng, 1988) had been reported earlier. The other pyrethroids cypermethrin, deltamethrin and fluvalinate were also not highly harmful to the larvae of *M. boninensis*. Similar observations on the tolerance of chrysopids to synthetic pyrethroids were made by Grafton-Cardwell and Hoy (1985), Mizell and Schiffhauer (1990) and Plapp and Bull (1978). These pyrethroids had also shown relatively lower residual toxicity to both larvae and adults of *M. boninensis*. According to Jac and Casida (1974), the pyrethroids were detoxified by esterases produced by the chrysopid.

Endosulfan (0.07%) was found moderately toxic to the larvae, and highly toxic initially to the adults of *M. boninensis*, but it did not persist for a longer time. Our findings also support Plapp and Bull (1978), Franz *et al.* (1980), Brettel (1982), Mizzel and Schiffhauer (1980), who had reported low toxicity of endosulfan (0.05%) to other species of *Chrysopa*. Methyl demeton was comparable to endosulfan for its initial and residual toxicity to *M. boninensis*. Phosalone 0.05% had been considered generally safe to many *Chrysopa* species (Franz *et al.*, 1980; Babrikova, 1982; Krishnamoorthy, 1985; Singh and Varma, 1986; Mizzel and Schiffhauer, 1990). But the same chemical (0.07%) proved harmful to both the larvae and adults of *M. boninensis* in the present study. According to Lingren and Ridgway (1967), there

Table 3. Residual toxicity of insecticides to the larvae of *M. boninensis*

Treatments	Mortality of larvae (arcsin √%)			Mean
	Days after application			
	1	7	114	
Dimethoate	0.57	0.57	0.57	0.57
Methyl demeton	0.57	0.57	0.57	0.57
Endosulfan	28.77	0.57	0.57	0.57
Malathion	90.00	30.98	0.57	0.57
Chlorpyriphos	54.76	0.57	0.57	0.57
Quinalphos	0.57	0.57	0.57	0.57
Phosphamidon	28.77	0.57	0.57	9.97
Monocrotophos	58.99	54.76	0.57	28.11
Methyl parathion	0.57	0.57	0.57	0.57
Cypermethrin	30.98	26.55	0.57	19.37
Carbaryl	0.57	0.57	0.57	0.57
Phosalone	30.98	0.57	0.57	10.71
Deltamethrin	0.57	0.57	0.57	0.57
Acephate	0.57	0.57	0.57	0.57
Fluvalinate'	0.57	0.57	0.57	0.57
Fenthion	46.90	28.77	0.57	25.41
Dichlorvos	0.57	0.57	0.57	0.57

	SEM	Level of Significance	C.D. (P = 0.05)
Treatments (A)	0.63	0.01	1.76
Days after application (B)	0.26	0.01	0.74
Interaction (A x B)	1.08	0.01	3.04

were variations in response among different species of chrysopids to the same pesticide. Dimethoate had also shown comparatively low initial and residual toxicity than the other insecticides to the larvae but proved highly toxic initially to the adults of *M. boninensis*. Brettell (1982) reported dimethoate as less toxic to *C. congrua* Walker, but the same was found highly harmful to many other species of *Chrysopa*. Similar results on the high toxicity of acephate and carbaryl (Hassan *et al*., 1987), chlorpyriphos and phosphamidon (Hassan *et al*., 1988), monocrotophos and quinalphos (Singh and Varma, 1986), Malathion (Wilkinson *et al*., 1975), methyl parathion (Lingren and Ridgway, 1967) to the other species of *Chrysopa* had been reported earlier.

Both the larvae and adults of *M. boninensis* were found unaffected by any of the fungicides in the present study. Dicofol had also been reported to be less toxic to *C. vulgaris* (Hoda and Hafez, 1981), *C. sinica* (Za and Zheng, 1988), *C. septempunctata* (Babrikova, 1982) and *Chrysoperla carnea* (Steph.) (Franz *et al*., 1980). But Mizell and Schiffhauer (1990) observed dicofol to be toxic to the adults but not to the larvae of *C. rufilabris*. The non-toxic nature of fungicides like triazol and mancozeb (Hassan et al., 1991), chlorothalonil (Hassan *et al*., 1988). zineb (Babrikova, 1982) and dinobuton (Babrikova, 1980) to different species of *Chrysopa* was recorded earlier.

It is concluded that fungicides/acaricides could be applied safely when *M. boninensis* is

Table 4. Residual toxicity of insecticides to the adults of *M. boninensis*

Insecticides	Mortality of adults (Arcsin √%)							Mean
	Days after application							
	1	7	14	21	28	35	42	
Dimethoate	90.0	63.90	0.57	0.57	0.57	0.57	0.57	22.39
Methyl demeton	21.13	0.57	0.57	0.57	0.57	0.57	0.57	3.51
Endosulfan	77.68	23.85	0.57	0.57	0.57	0.57	0.57	14.91
Malathion	90.0	90.0	90.0	52.75	0.57	0.57	0.57	46.35
Chlorpyriphos	90.0	90.0	90.0	90.0	90.0	54.76	0.57	72.19
Quinalphos	90.0	90.0	54.76	0.57	0.57	0.57	0.57	33.86
Phosphamidon	90.0	90.0	90.0	46.90	0.57	0.57	0.57	45.52
Monocrotophos	90.0	54.76	48.83	0.57	0.57	0.57	0.57	27.98
Methyl parathion	90.0	90.0	63.90	0.57	0.57	0.57	0.57	35.17
Cypermethrin	90.0	90.0	90.0	74.91	0.57	0.57	0.57	49.53
Carbaryl	90.0	54.76	44.98	0.57	0.57	0.57	0.57	27.43
Phosalone	90.0	58.98	52.75	0.57	0.57	0.57	0.57	28.82
Deltamethrin	90.0	0.57	0.57	0.57	0.57	0.57	0.57	13.35
Acephate	90.0	90.0	90.0	66.12	0.57	0.57	0.57	48.26
Fenvalerate	90.0	20.98	28.77	26.5	0.57	0.57	0.57	19.00
Fluvalinate	0.57	0.57	0.57	0.57	0.57	0.57	0.57	19.00
Fenthion	90.0	90.0	90.0	90.0	46.90	0.57	0.57	58.29
Dichlorvos	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57
Mean	72.99	55.96	46.33	28.41	9.11	3.58	0.57	-

	SEM	Level of Significance	C.D. (P = 0.05)
Insecticides (A)	0.50	0.01	1.40
Days after application (B)	0.32	0.01	0.90
Interaction (A x B)	1.33	0.01	3.17

active in the field. Dichlorvos, endosulfan and methyl demeton which showed low residual toxicity could be considered for field application. A week after the spray application, chrysopids can be released for pest control. According to Meyerdirk *et al.* (1982), the reduced toxic activity of pesticides to beneficial organisms is desirable for an integrated control programme.

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