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Effects of Two Organophosphorus Pesticides Diazinon-60 EC and Dimecron-100 SCW on a Zooplankton, *Diaptomus*

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Abstract: Experiments were carried out to find the effect of Diazinon-60 EC and Dimecron-100 SCW on *Diaptomus*. The *Diamptmus* were exposed to various concentrations of Diazinon-60 EC and Dimecron-100 SCW. The median lethal concentrations of Diazinon-60 EC and Dimecron-100 SCW for 48 hours of exposure on *Diaptomus* were 0.3530 and 1.2809 ppm respectively.

Key words: Diazinon, dimecron, *Diaptomus*

Introduction

Environmental pollution and biosphere study has attracted the attention of scientists all over the world (Lamba, 1977; Pal, 1977). Of the pollutants, pesticides and even among these, insecticides have been much talked about (Lamba, 1977). Pesticides are useful tools in agriculture and forestry but gradual degradation of aquatic ecosystem and consequent disaster can not be ignored (Konar, 1975; Basak and Konar, 1977).

Pesticides at high concentration are known to reduce the survival, growth and reproduction of fish and other aquatic organisms (McKim *et al*., 1975) and produce many visible effects on aquatic lives (Johnson, 1968). In assessing the toxicity of pesticides to aquatic invertebrates and vertebrates it is found that most of the pesticides are highly toxic to phytoplankton, zooplankton and other aquatic organisms.

Among the aquatic lives fish play a vital role for the supply of animal protein. Nutritionally fish is unparallel containing protein, lipid, vitamins and a trace amount of carbohydrates. Many aquatic invertebrates especially crustaceans, cladocers, copepods and insect larvae that form an important source of food for many species of fish are reported to be more sensitive to pesticides than fish (Johnson and Julin, 1980). Zooplankton are used as bioindicators of pollution due to their world wide distribution, strategic position in the food webs, rapid changes in their populations with disturbance in the ecosystem, intimate contact with the surrounding environment and effects of toxicant throughout their life cycle (Kaur and Ansal, 1996). Zooplankton, *Daphnia magna* is more sensitive to the chemicals than rainbow trout (Lilius *et al*., 1994). In the present experiments, *Diaptomus* was preferred as zooplankton because it is available in different water bodies and serves as an important food of fish. However, very little work has been done on the effects of pesticides on fish of Bangladesh and no work has yet been conducted on the effects of pesticides on invertebrates particularly zooplankton which helps substantially by its role in the aquatic food chain. The experiments were conducted to determine the LC_{50} values of zooplankton, *Diaptomus* for 48 hours exposure time.

Materials and Methods

Site of experiments: The experiments were conducted in Wet Laboratory of the Faculty of Fisheries, Bangladesh Agricultural University, Mymensingh, Bangladesh from May to August 2000.

Collection of Zooplankton: The zooplankton, *Diaptomus* was collected from the experimental ponds of the Faculty of Fisheries, Bangladesh Agricultural University, Mymensingh, Bangladesh campus using plankton net of mesh size 200μ. The test zooplankton was first collected as zooplankton composition. Then it was acclimated for half an hour with tap water in 100 ml glass beakers. The zooplankton composition then carefully screened by a synthetic net of mesh size 300-350μ. As a result smaller zooplankton screened out and mainly *Diaptomus* with a few other larger zooplankton retained in the net. They were then transferred to another 1000 ml beaker in such a manner that they were never taken out of water. A sample of these was taken into a petridish, diluted with tap water. The *Diaptomus* as described by Ward and Whipple (1959) was then carefully separated one by one using dropper and magnifying glass. In case of confusion the separated zooplankton was confirmed by the observation under microscope.

Zooplankton bio-assay: Two different experiments were conducted at the same time with pesticides Diazinon-60 EC and Dimecron-100 SCW. Twenty one, glass beakers (1000ml) were arranged in three rows on a cemented table for each experiment. Earlier the beakers were washed with detergent and then rinsed in sequence with clean water followed by two or more changes of tap water. Each of the beaker was filled with 500 ml tap water. There were six treatments each with three replications including the control.

For definitive lest of 48 hours exposure, six different concentrations of Diazinon-60 EC and Dimecron-100 SCW were used and a control was maintained for both the cases each having three replications. The required test materials were measured by a micropipette. In the test beaker desired concentrations of pesticides were poured carefully and mixed gently with a glass rod. Ten acclimated *Diaptomus* that were separated earlier were released in each beaker containing different concentrations of pesticides as well as the control. The tests were done in laboratory conditions at the prevailing room temperature.

Earlier a range finding test was performed to determine LC_{50} values with different concentrations of Diazinon-60 EC and Dimecron 100-SCW for 48 hours of exposure and it was found that no *Diaptomus* died below the concentration of 0.14125 ppm and all of them died at the concentration 4.25 ppm of Diazinon-60 EC. On the other hand in case of Dimecron-100 SCW no *Diaptomus* died below the concentration of 0.2825 ppm and all of them died at a concentration of 9.04 ppm. Accordingly six concentrations were chalked out between 0.14125 and 4.52 ppm and 0.2825 and 9.04 ppm for Diazinon-60 EC and Dimecron-100

SCW respectively. The concentrations of Diazinon-60 EC and Dimecron-100 SCW were 0.14125, 0.2825, 0.5650, 1.1300, 2.2600 and 4.5200 as well as 0.2825, 0.5650, 1.1300, 2.2600, 4.5200 and 9.0400 ppm respectively.

After release of *Diaptomus* into the test media, the behaviour with respect to its pesticides polluted environment was observed and dead zooplankton were recorded and removed using dropper as soon as they were seen. The end point was settled as complete loss of movement and settling at the bottom. Dead zooplankton was removed and mortality was recorded at 6, 12, 24, 36 and 48 hours of exposure time.

Temperature, dissolved oxygen and pH of the test media were recorded daily. The temperature was measured by a thermometer, dissolved oxygen and pH were measured by DO meter (Model 2020, UK) and pH meter (Model YSI 58, USA) respectively.

The LC_{50} values for 48 hours exposure was calculated by probit analysis of the computer program Statistical Programme for Social Science (SPSS).

Results and Discussion

The cumulative mortality percentage of the zooplankton, *Diaptomus*, at different concentrations of Diazinon-60 EC after 48 hours exposure is given in Table 1. All the tested *Diaptomus* died at the dose 4.5200 ppm of Diazinon-60 EC within 48 hours. At the doses 0.14125, 0.2825, 0.5650, 1.1300 and 2.2600 ppm, 23%, 50%, 67%, 73% and 83% mortality were observed within the same exposure time. None of the *Diaptomus* died in control. The median lethal concentration value (LC_{50}) for 48 hours of exposure on *Diaptomus* is presented in Table 2. The LC_{50} value was found to be 0.3530 ppm for 48 hours of exposure. Fores and Comin (1988) reported LC_{50} value of Malathion + Lindane biocide on *Moina* to be 0.34 ppm. The LC_{50} value of the present experiment coincided with the results of Fores and Comin (1988). Chaudhuri (1975) found that a few of the zooplankters (cladocerns, copepods and a few rotifers) remained alive when exposed to 0.3 ppm Aldrin for 20 hours but all died at 0.4 ppm within 4 hours. The median lethal dose of present experiment is also similar to the findings of Chaudhuri (1975), although the pesticide and exposure time were different. Ferrando *et al*. (1995) reported 24 hours static LC_{50} value of Lindane on *Daphnia magna* to be 1.64 mg/l

Table 1: Cumulative mortality percentage of *Diaptomus* to Diazinon 60 EC treatments.

Concentration (ppm)	Cumulative mortality (%)				
	6h	12h	24h	36h	48h
Control	00	00	00	00	00
0.14125	00	00	00	13	23
0.28250	00	00	10	37	50
0.56500	00	00	23	37	67
1.13000	00	00	30	43	73
2.26000	00	00	53	73	83
4.52000	00	00	60	77	100

Table 2: Probit analysis on the effect of Diazinon 60EC to *Diaptomus* at 48 hours of exposure.

Concentration (ppm)	Log concentration	No. of organisms	No. of organisms dead	Percent kill	*Probit	LC_{50} (ppm)	95% confidence limit	
							Lower (ppm)	Upper (ppm)
0.0000	--	30	00	00	--	0.3530	0.2322	0.4858
0.14125	-0.85	30	07	23	4.39			
0.28250	-0.85	30	15	50	4.85			
0.56500	-0.85	30	20	67	5.31			
1.13000	-0.85	30	22	73	5.78			
2.26000	-0.85	30	25	83	6.24			
4.52000	-0.85	30	30	100	6.72			

Intercept (a) = 0.69810 Regression coefficient (b) = 1.54395 Heterogenicity (χ^2) = 3.794 (Not significant)
*Probit = N.E.D. increased by 5 N.E.D. = Normal Equivalent Deviate

Table 3: Cumulative mortality percentage of *Diaptomus* to Dimecron-100 SCW treatments

Concentration (ppm)	Cumulative mortality (%)				
	6h	12h	24h	36h	48h
Control	00	00	00	00	00
0.28250	00	00	00	00	03
0.56500	00	00	10	17	30
1.13000	00	13	20	23	43
2.26000	00	30	43	43	63
4.52000	30	60	77	83	90
9.0400	50	77	87	97	100

Table 4: Probit analysis on the effect of Dimecron 100 SCW to *Diaptomus* at 48 hours of exposure

Concentration (ppm)	Log concentration	No. of organisms	No. of organisms dead	Percent kill	*Probit	LC_{50} (ppm)	95% confidence limit	
							Lower (ppm)	Upper (ppm)
0.0000	--	30	00	00	--	1.2809	1.0107	1.6132
0.28250	-0.55	30	01	03	3.47			
0.56500	-0.25	30	09	30	4.17			
1.13000	-0.05	30	13	43	4.87			
2.26000	-0.35	30	19	63	5.56			
4.52000	-0.66	30	27	90	6.28			
9.04000	-0.96	30	30	100	6.98			

Intercept (a) = -0.25011 Regression coefficient (b) = 2.32570 Heterogenicity (χ^2) = 3959 (Not significant)
*Probit = N.E.D. increased by 5 N.E.D. = Normal Equivalent Deviate

Table 5: Water quality parameters of the test media on *Diaptomus* during the experimental period.

Conc. (ppm)	Diazinon-60EC			Conc. (ppm)	Dimecron-100 SCW		
	Temperature (°C)	Dissolved oxygen (ppm)	pH		Temperature (°C)	Dissolved oxygen (ppm)	pH
Control	27.17± 0.056	5.54± 0.103	7.31 ± 0.23	Control	27.92± 0.150	5.43± 0.090	7.36 ± 0.17
0.14125	27.86± 0.140	4.43± 0.075	7.58± 0.07	0.28250	27.86± 0.220	5.28± 0.055	7.67 ± 0.09
0.28250	27.68± 0.175	4.39± 0.113	7.61 ± 0.12	0.56500	27.42± 0.315	5.19± 0.042	7.75 ± 0.05
0.56500	27.88± 0.054	4.23± 0.060	7.75± 0.10	1.13000	27.56± 0.461	5.11 ± 0.039	7.74 ± 0.04
1.13000	28.01 ± 0.110	4.12± 0.140	7.81 ± 0.90	2.26000	28.10± 0.322	5.03± 0.040	7.70± 0.07
2.26000	28.31 ± 0.190	4.11 ± 0.095	7.88± 0.13	4.52000	28.15± 0.134	4.96± 0.035	7.77 ± 0.23
4.52000	28.04± 0.060	4.00± 0.060	7.95± 0.53	9.0400	28.11 ± 0.150	4.95± 0.051	7.79± 0.06

which is contray to the present work, however the pesticide and test zooplankton were different. The effect of different concentrations and exposure time against Dimecron-100 SCW as shown by the cumulative mortality percentage of *Diaptomus* are presented in Table 3. Hundred percent mortality was observed at the dose of 9.0400 ppm within 48 hours. At the doses 0.2825, 0.5650, 1.1300, 2.2600 and 4.5200 ppm, 3%, 30%, 43%, 63% and 90% mortality were observed for the same exposure time. None of the *Diaptomus* died in the control.

Physiological activities i.e. respiration, metabolism, feeding, breeding etc. of aquatic organisms are inhibited by the effects of pesticides (Rand and Petrocelli, 1985). In present study, *Diaptomus* died due to inhibition of respiratory function. The result was similar with the findings of Rand and Petrocelli (1985).

The median lethal concentration value (LC_{50}) for 48 hours of exposure on *Diaptomus* is presented in Table 4. The LC_{50} value was found to be 1.2809 ppm for 48 hours of exposure. Ferrando *et al.* (1995) conducted acute and chronic tests with Lindane on *Daphnia magna* and reported LC_{50} value to be 1.64 mg/l. The LC_{50} value of the present work was very similar to the findings of Ferrando *et al.* (1995), although the pesticide and zooplankton were different. The result was also close to the result of Rachyunas (1985), where *Diaptomus* was resistant to 1 ppm Flibol pesticide in a nursery pond. The LC_{50} value of present work was higher than that of *Moina* against Malathion + Lindane as reported by Fores and Comin (1988).

The water quality parameters viz., temperature, dissolved oxygen and pH of the test media are presented in Table 5. The average dissolved oxygen was higher in the lower concentrated media. However, the parameters varied little in different treatments and were in agreement with their requirements. Metabolites and pesticidal effects might be the probable reasons of declining oxygen concentration in the lower to higher concentrated test media during present study. However, the water quality parameters of the test media varied a little and were within the desirable range of fish and other aquatic invertebrates (Boyd, 1979).

Zooplankton, *Diaptmus* have an excellent potential as rapid and sensitive predictors of toxicity test because of their diversity and short, sensitive life cycles. Research is also needed to find the bio-accumulation of pesticides and what actually happens in the fate of pesticide treated zooplankton in respect of growth, reproduction, fecundity, hatching success, genetic drift etc.

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