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Sensitivity of Selected Zooplankton Exposed to Phosphamidon, Fenitrothion, and Fenthion

K. Kaur, M. D. Ansal

Department of Fisheries, Punjab Agricultural University, Ludhiana (Pb.) 141 001, India

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In recent years efforts have been made to develop biomonitoring systems for determining different levels of pesticidal pollution in the water bodies which get contaminated as a consequence of run off water from pesticide treated areas (Ridgway et al. 1978; Ernst et al. 1991). The major stress has been focussed on the microinvertebrates, such as zooplankton. Zooplankton are used as bioindicators of pollution due to their worldwide distribution, strategic position in the food webs, rapid changes in their populations with disturbance in the ecosystem, intimate contact with the surrounding environment and effect of toxicant throughout their life cycle.Therefore, it is important on one hand to determine the sensitivity of these organisms to different pesticides and on the other hand to select the most sensitive species as test organisms which can act as a bioindicator of pesticidal pollution.

MATERIALS AND METHODS

Three zooplankton genera belonging to three different groups, viz., Rotifera (Branchionus spp), Cladocera (Moina spp) and Copepoda (Mesocyclops spp) were selected for bioassay experiments with three organophosphate pesticides, viz., Phosphamidon (82.5% EC), Fenitrothion (50% EC) and Fenthion (80% EC). These pesticides were purchased from local market (Table 1). All the zooplankton genera were collected from ponds of Department of Fisheries, Punjab Agricultural University, Ludhiana and cultured at 24.5 ± 1.5°C in the laboratory in 1-L glass jars having filtered pond water treated with mixture of cow dung (1) and poultry droppings(l), @ 1% infusion. Different pesticide concentrations were prepared by diluting freshly prepared stock solution (1 mL/L of technical mixture) with filtered pond water. Physicochemical characteristics of the pond water used for bioassays

Correspondence to: K. Kaur

Table 1. Details of three organophosphate pesticides used in the bioassays.

S.No.	Commercial name	Trade name	Technical name
1.	Phosphamidon	Dimecron^{R} (82.5% EC)	2-chloro 2-diethyl carbanyl-1-methyl vinyl dimethyl phosphate
2.	Fenitrothion	Sumithion^{R} (50% EC)	0, 0-Dimethyl 0-(4-Nitro-m-Tolyl) Phosphorothioate
3.	Fenthion	Lebayacid^{R} (80% EC)	0,0-Dimethyl 0 (4-(Methylthio) -m-Tolyl) Phosphorothioate.

were: temperature, 24.5 ± 1.5°C; pH, 7.0-7.5; DO, 4.3-4.5 mg/L; total alkalinity, 313-319 mg/L; hardness, 203-215 mg $CaCo_3$/L.

The pesticide concentration range in all the tests was based on preliminary range finding tests. Triplicate tests were run for each pesticide concentration and control. Ten individuals (adults) were exposed to each concentration in each petri plate (12.5 cm dia.) containing 100 mL of test solution . Dead zooplankton were counted and removed after every 12 hr through 48 hr of exposure. 24-hr and 48-hr LC50 values of each pesticide used for each zooplankton genera were calculated by Probit Analysis (Finney 1971). To evaluate differences in species sensitivity, the data were analysed on computer by using Student's Newman Keul's Test (Zar 1984).

RESULTS AND DISCUSSION

The 24-hr and 48-hr LC50 values for all the three pesticides are listed in Table 2. Comparison of LC50 values and relative toxicity of pesticides indicate that phosphamidon is most toxic followed in order of decreasing toxicity by fenitrothion and fenthion. Fenitrothion is 1.1 times less toxic than phosphamidon to Mesocyclops spp., 1.5 times less toxic to Moina spp. and 11.0 times less toxic to Brachionus spp. Fenthion is 1.87 times less toxic than phosphamidon to Mesocyclops spp., 10.0 times less toxic to Moina spp. and 16.0 times less toxic to Brachionus spp.

The data pertaining to LC50 values and relative toxicity of pesticides further reveal that Moina spp.

Table 2. LC50 value (µL/L of technical mixture) for zooplankton exposed to various pesticides and relative toxicities (R.T.)

Pesticide	*Brachionus* spp.			*Moina* spp.			*Mesocyclops* spp.		
	24-hr LC50	48-hr LC50	R.T.	24-hr LC50	48-hr LC50	R.T.	24-hr LC50	48-hr LC50	R.T.
Phosphamidon (82.5% EC)	3.80^{a}	0.36^{x}	1.0	0.005^{b}	0.00007^{y}	1.0	4.34^{a}	1.69^{x}	1.0
Fenitrothion (50% EC)	6.30^{a}	3.98^{x}	11.0	0.05^{b}	0.0001^{y}	1.5	5.01^{a}	1.86^{x}	1.1
Fenthion (80% EC)	7.24^{a}	5.62^{x}	16.0	0.63^{b}	0.001^{y}	10.0	5.37^{a}	3.16^{x}	1.87

-R.T. of Fenitrothion and Fenthion to all the three zooplankton genera was calculated by comparing their 48-hr LC50 values with that of Phosphamidon (most toxic) for the respective zooplankton genera

-Values with different superscripts differ.significantly (p=0.05)
a,b indicate differences in 24-hr LC50 values
x,y indicate differences in 48-hr LC50 values

is most sensitive species to all the three pesticides tested, whereas Mesocyclops spp. is least sensitive to phosphamidon and Brachionus spp. is least sensitive to both fenitrothion and fenthion. These observations are in agreement with those of Malacea and Gruia (1965) and Didia et al. (1975), that Moina spp. is most sensitive. Higher sensitivity of Moina spp. may be due to its structural and physiological simplicity and its intimate contact with the surrounding medium (Macek and Saunders 1970). Least sensitivity of rotifers, as compared to cladocerans and copepods, to orqanophosphate pesticides has also been reported by Jhinqran and Pulin (1985) and Kumar et al. (1988). They observed that all the cladocerans and copepods die at 0.25 to 3.0 mq/L of malathion, fumadol, fenitrothion, fenthion and diptrex without affecting the rotifers.

The 24-hr LC50 for fenitrothion, in the present case was 6.30 µL/L for Brachionus spp., which is insignificantly different from LC50 value of 6.68 mg/L reported for Brachionus calyciflorus by Ferrando and Moliner (1991). Ruber and Basker (1968) found 24-hr LC50 value of fenthion for Diaptomus spp. and Cyclops spp. to be 0.1 and 5.0 mg/L respectively,indicatinq Mesocyclops spp. (LC50 is 5.3 µL/L in the present studies) more resistant to fenthion than Diaptomus spp. and is equally sensitive as Cyclops spp.

No relevant data are available on LC50 values of tested orqanophosphate pesticides for Moina spp. except the report of Kumar et al. (1988) that is more sensitive to orqanophosphates as compared to copepods and rotifers. The same is revealed by the present studies.

From the physical responses like irritability, violent movements in higher concentrations of pesticides and progressive loss of equilibrium and inability to swim just before death, it can be concluded that mortality of zooplankton is caused by the effect of pesticides on the nervous system. These pesticides have already been reported to cause mortality in invertebrates and vertebrates by inhibiting cholinesterase enzyme (Corbett 1974). Pramanik and Konar (1990) also reported similar physical responses in Diaptomus spp. exposed to 0.18 to 0.86 ppm. of zolon, an orqanophosphate pesticide.

Present studies revealed that Moina spp. is most sensitive to orqanophosphate pesticides and can be used as bioindicator of pesticidal pollution.

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