Bull. Environ. Contam. Toxicol. (2005) 74:610–613

DOI: 10.1007/s00128-005-0627-x

Bulletin of Environmental Contamination and Toxicology

Acute Toxicity of Synthetic Pyrethroids to Indian Major Carp, *Catla catla* L.

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Received: 29 April 2004/Accepted: 10 December 2004

Synthetic pyrethroids have been known to enter the aquatic environment from agricultural runoff or drift from aerial and ground-based spraying applications. Hence, they may pose a serious threat to fish populations by direct exposure of young fish which tend to be less tolerant to pesticides (Kumaraguru and Beamesh 1981). This polluted stream and river water is also used for inland fish culture thereby having undesirable implications.

It is important to evaluate the toxicity of newly marketed pesticides on fish as the latter form an important part of human food. Amongst a number of edible fish found in Indian freshwater bodies, *Catla catla* is a very popular food fish. Therefore, this study was undertaken to determine the lethal concentration of these pesticides on catla. The objective of the acute toxicity test was to determine the concentrations of cypermethrin, deltamethrin and fenvalerate that elicit a specific response to the test organism (catla) in a relatively short period of time.

MATERIALS AND METHODS

The test compounds, technical grade cypermethrin, deltamethirn and fenvalerate of purities (90, 98 and 92% respectively) were obtained from Rallis India Pvt. Ltd., Mumbai, India. The characteristics of the pesticides are given in the Table 1.

Catla fingerlings (5cm, 2.02± 0.1 g) were obtained from a fish farm in India and were acclimatized for 15 days at 28 °C in the laboratory. Laboratory-made fish food was given regularly (GE, 3500 Kcal/kg) and tank water (pH: 7.2, Salinity-nil, Hardness : 100 ppm, D.O.: 4.6 ppm) was completely changed everyday to remove metabolic wastes.

Concentrations of the test compounds used in the short-term definitive tests were between the highest concentration at which there was 0% mortality and the lowest concentration at which there was 100% mortality in the range finding tests. Concentrations were examined in triplicate. 40 fingerlings were added to each tank filled with 100 litres of water. Water was changed everyday over 4 days. Henceforth, the replacement of the water medium was followed by the addition of the desired dose of the test compounds. Mortality was determined every 24 hrs.

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For LC_{50} calculation, mortality was recorded every 24 hrs and dead animals were removed. Duncan's multiple range test (DMRT) was employed for comparing mean mortality values after estimating the residual variance by repeated measures ANOVA (Winner 1971) for arc sine transformed mortality data (dead individuals/ initial number of individuals). Time of exposure was the repeated measure factor while treatment (concentration and control) was the second factor. In addition, LC_{50} values were compared by the method of APHA (1995). The LC_{50} with 95% confidence limit for pyrethroids were determined/estimated for 24, 48, 72 and 96 hr by probit analysis (Finney 1971).

Table 1. Characteristics of cypermethrin, deltamethrin and fenvalerate

Commercial Preparation	Mol formula	Mol wt	Purity (TG)	Acute oral LD_{50} rats ppm
Cypermethrin	$C_{22}H_{19}CL_2NO_3$	416.3	90%	250-4150
Deltamethrin	$C_{22}H_{19}Br_2NO_3$	505.2	98%	135-5000
Fenvalerate	$C_{25}H_{22}C1NO_3$	419.9	92%	451

RESULTS AND DISCUSSION

The use of synthetic pyrethroids is growing which is attributed to its low mammalian toxicity (Parker et al. 1984), biodegradability (Leahey 1979), high efficacy and non-phytotoxicity. Pyrethroids adhere to suspended organic matter in water. Thus the half-life of pyrethroids in water depends on water quality (Agnihotri 1986). This class of agricultural insecticides has emerged as a complement to organophosphates, organochlorines and carbonates and is more popular due to its effectiveness to a wide range of insects. There are several synthetic pyrethroids amongst which cypermethrin, deltamethrin, and fenvalerate are commonly used for the control of insect pests of cotton, fruits and vegetables.

The acute toxicity (LC_{50}) calculated over a 96 hr period for cypermethrin was the lowest (4 μg/L). Fenvalerate and deltamethrin had an LC_{50} of 6 and 55 μg/L respectively on catla (Table 2). Toxicity of cypermethrin was 13-fold greater than that of deltamethrin and the toxicity of fenvalerate was 9.2-fold greater than that of deltamethrin (Table 2).

The recommended dose of the pesticide for stored grain is 30 mg active ingredient (a.i.) per square meter of the surface of each layer of the bag. The pesticide is considered environmentally safe because it works rapidly on insects, has low water solubility and is quickly degraded. However little is known about its safety level. Reports that documented acute toxicity of deltamethrin for a few species of fish (Nemesok et al. 1999) are inadequate. The input of materials from agricultural fields produces marked short-term changes in abiotic conditions of headwaters. In addition to an increased hydraulic stress there are increased concentration of suspended particulates, nutrients and pesticides (Hill 1989).

Shires and Bennett (1985) studied the impact of spray drift of cypermethrin applied to agricultural fields that directly bordered on headwater streams. They detected residues of the active substances in the water. Non-target organisms such as aquatic invertebrates andfish are extremely sensitive to neurotoxic effects of these insecticides when they enter surface waters (Reddy and Philip 1994). Pyrethroids have been shown to be up to 1000 times more toxic to fish than to mammals and birds at comparable concentration (Bradbury and Coates 1989a). The environmental concentrations of cypermethrin are often below those that are lethal to many freshwater teleosts (Phillip et al. 1995).

The safe concentrations of cypermethrin and fenvalerate to catla were found to be 1 μg/L and 2 μg/L for deltamethrin. Therefore usage above these may be detrimental to catla. Cypermethrin was found to be more toxic to catla than to *Cyrinus carpio*. *Cyrinus carpio* exhibited 50% mortality from 50 to 70 mμg/L of cypermethrin and 120 to 140 mμg/L, for permethrin (Malla-Reddy et al. 1995). The LC_{50} (96-hour) for cypermethrin in rainbow trout was 8.2 μg/L, and in bluegill sunfish was 1.8 μg/L. Short-term exposure to the pyrethroid esfenvalerate also resulted in reduced fecundity of Australian crimson spotted rainbow fish and the failure of eggs to hatch (Barry et al. 1995). Although it has been claimed that deltamethrin sprayed at the rate of 10-20 mg a.i. /m^2 leaves no detectable level of residue (Agnihotri and Yadav 1991), its high toxicity to fish when dissolved in an organic solvent renders it most dangerous for use near aquatic habitats. Synthetic pyrethroid insecticides are potent neurotoxicants and their modes of action have been well described in many species of invertebrates and vertebrates (Bradbury and Coates 1989b).

Table 2. Acute toxicity of cypermethrin, deltamethrin and fenvalerate to catla at different time intervals.

Experimental time (hrs)	**LC_{50} (μg/L)**		
	Cypermethrin	**Deltamethrin**	**Fenvalerate**
24	4.5 (4-6.2)	65 (49-79)	82 (71-99)
48	4.1 (3.1-5.7)	60 (41-72)	6.5 (2.9-7.2)
72	3.9 (3.1-5.3)	56 (50-64)	6 (2.3-8.1)
96	4 (3.1-5.6)	55 (49-61)	6 (2.3-8.1)
Safe Concentration (μg/L)	1	2	1
Relative Toxicity	13.8	1	9.2

Acknowledgements. S.S.Tandon thanks the Council of Scientific and Industrial Research, India for providing the funds for carrying out this Research. Thanks also to Mrs. S.S.Gajbhiye for manuscript preparation.

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