Asian Fisheries Science 2(1989):249-254.
Asian Fisheries Society, Manila, Philippines

https://doi.org/10.33997/j.afs.1989.2.2.010

Toxicity of Selected Pesticides to the Snakehead, *Channa punctata*

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Abstract

Bioassay trials conducted in triplicate determined 24-hour and 48-hour LC_{100} values to the snakehead, *Channa punctata*, of Sumithion (fenitrothion), DDVP, Phyphanon (malathion), dieldrin and Phostoxin (phosphine). Two recommended piscicides, bleaching powder and rotenone, were also evaluated for cost comparisons. The 24-hour LC_{100} values ranged from 15 ppm of bleaching powder to 0.25 ppm of Phostoxin. Detoxification of Phostoxin, as determined by survival of carp fry, occurred in 4 days in laboratory tanks at 23°C and in 1 day in earthen ponds at 30°C. Rotenone required 6 days at 2.5 ppm and bleaching powder 17 days at 15 ppm to detoxify in laboratory tests at 23°C. Indian-produced phosphine was of least cost for fish eradication, followed by dieldrin, Phostoxin, and bleaching powder.

Introduction

In the 1950s-1960s the organochlorine insecticides were examined for use in fisheries to clear waters of predatory and weed fishes in the USA (Lawrence 1950) and Southeast Asia (Soong and Merican 1958; Kok and Pathak 1966). These compounds, such as endrin, lindane and DDT, were effective at concentrations of 0.1 ppm or less and hence were very economical and attractive to farmers and managers. Hickling (1962) used endrin to clear ponds in Malaysia, but concluded that the search for a cheap, harmless piscicide must continue. The toxicity to other life and accumulation in the food chain led to the disuse of the most persistent organochlorines.

However, organochlorine insecticides remain in wide use in Southeast Asia. In Thailand dieldrin was found to be the most

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common insecticide detected in water samples and was in 83% of sampled fish (Sidthi et al. 1983). In Bangladesh fingerling producers who purchased fry at the hatchery of the Freshwater Aquaculture Research Station, Mymensingh, reported using endrin, dieldrin and Indian-produced Thiodon and Hidron as piscicides (Rahman et al., unpublished data). We observed that endrin and dieldrin are still the most prevalently used compounds to clear ponds.

These compounds represent a health hazard to fish and aquatic life and to the human community. Dieldrin concentrates in aquatic invertebrates several hundred to several thousand times the applied dosages (Johnson and Finley 1980) and would be further concentrated when the invertebrates were consumed by fish. Endrin hazards including fish die-offs have been noted by Konar (1975). Organochlorine pesticides have been suggested as contributing to the recent epizootics of ulcerative fish diseases in Southeast Asia (Tonguthai 1985).

An urgent need for fish culture is an adequate supply of rotenone or another nontoxic piscicide at low cost to replace organochlorine use. Toxicity of organophosphorus insecticides to fish and aquatic insects has been examined (Srivastava and Konar 1966; Sreenivasan and Swaminathan 1967; Srivastava and Konar 1968; Konar 1969).

We designed a study to determine the 24-hour and 48-hour LC_{100}s of some readily available pesticides to the snakehead, *Channa punctata*. This fish was determined to be a major component of the pond fish community based on relative abundance and biomass (Hill and Kibria 1979). *Channa* sp. were also particularly noted in the recent epizootics of ulcerative fish diseases in Thailand and Burma (Tonguthai 1985). The cost of employing each compound in eradication of snakeheads was compared with the recommended controls of rotenone and bleaching powder to determine possible economic incentives for use of each chemical.

Materials and Methods

The study was conducted at the Freshwater Aquaculture Research Station (FARS), Mymensingh, Bangladesh in ten, 175-l stainless steel and glass tanks which were drainable. Bioassay methodology followed Johnson and Finley (1980). Test organisms *(Channa punctata)* were purchased in the local markets and varied in total length from 13 to 18 cm. Toxicants were procured from local sources and were commercial preparations.

Preliminary tests with each chemical identified the onset of mortality. From those levels, effects of increased concentrations were examined by first determining the 48-hour LC_{100} and then the 24-hour LC_{100} values. Three test concentrations with three replications and a control were made at a density below 1 $g \cdot l^{-1}$, i.e., four small or three large fish, per tank. The fish were acclimated in the aquaria for several days in well water (hardness, 120 ppm; pH, 7.3-7.7) and were not fed. The well water was changed and the test concentration was added. Mortality was recorded after 24 and 48 hours. Tanks were unaerated and temperature was ambient. Water temperatures ranged from 22 to 32°C. Oxygen concentrations remained above 3 ppm, and pH did not exceed 8.0 or fall below 7.0 during the tests.

Persistence of toxicity of selected compounds in use in aquaculture was determined to 10-day-old hatchlings of various carp species in 175-l aquaria. At 1-day intervals, 10 fry were added to a tank containing the previously determined 24-hour LC_{100} concentration and mortality was recorded over a 72-hour period.

Results

The test results of the seven compounds are displayed in Table 1, together with costs to treat a 0.1-ha pond, 1 m deep. Phostoxin was effective at the lowest concentration, 0.25 ppm 24-hour LC_{100} at 27°C, and at a treatment cost of $10.17. Rotenone cost was slightly higher, $12.50, and the detoxification period also slightly longer. The detoxification period in laboratory tanks for rotenone was 6 days and 4 days for Phostoxin. In an earthen pond treated with Phostoxin a water sample was not toxic to 10-day-old carp fry after 1 day. Water temperatures were higher in the pond, 30°C *vs.* 23°C. Murty (1986) indicates that the bioavailability of pesticides is affected by suspended particles. Although bleaching powder required the highest concentration of 15 ppm, it was the next most inexpensive, $15.00, to treat a 0.1-ha pond. However, the detoxification period in the laboratory tanks was 17 days at 23°C. Dieldrin was by far the least expensive of the tested toxicants, $5.50 at an effective concentration of 0.5 ppm. However, the persistence of toxicity was not evaluated. Organophosphorus compounds were lethal at high concentrations, 6-14 ppm, and consequently of high cost.

Table 1. Toxicity of various concentrations of commercial compounds to *Channa punctata*.

Compounds and concentrations (ppm)	Water temperature (C)	Average 24-hour mortality (%)	Average 48-hour mortality (%)	Treatment cost ($)[a]
Sumithion - 0,0-Dimethyl-0-(3-methyl-4-nitrophenyl) phosphorodithioate				
4.0	32	0.00 ± 0.00	0.00 ± 0.00	
6.0	"	16.67 ± 28.87	21.67 ± 33.70	
8.0	"	50.00 ± 16.70	58.43 ± 33.70	
9.0	"	66.67 ± 28.87	75.00 ± 25.00	
12.0	"	72.23 ± 25.45	100.00 ± 0.00	
14.0	"	100.00 ± 0.00		186.67
DDVP - 2,2-Dichlorovinyl dimethyl phosphate				
3.0	27	0.00 ± 0.00	0.00 ± 0.00	
4.5	"	33.33 ± 38.19	66.67 ± 38.19	
6.0	29	100.00 ± 0.00		68.70
Phyphanon - 0,0-Dimethyl-(1,2-Dicarbethoxyethyl) phosphorodithioate				
6.0	28	50.00 ± 0.00	91.67 ± 14.43	
8.0	"	83.33 ± 14.43	100.00 ± 0.00	
10.0	"	100.00 ± 0.00		66.67
Phostoxin - Aluminium phosphide				
0.05	27	8.33 ± 14.43	16.67 ± 28.87	
0.10	"	66.67 ± 14.43	100.00 ± 0.00	
0.25	"	100.00 ± 0.00		10.17
Bleaching Powder - Calcium hypochlorite				
10.0	23	58.33 ± 28.87	100.00 ± 0.00	
15.0	"	100.00 ± 0.00		15.00
Rotenone - C23H2206				
2.0	24	75.00 ± 25.00	100.00 ± 0.00	
2.5	"	100.00 ± 0.00		12.50
Dieldrin - 1,2,3,4,10,10-Hexachloro-exo-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-endo-exo-1,4,5,8-dimethanonapthalene				
0.2	24	8.33 ± 14.43	25.00 ± 25.00	
0.3	21	58.33 ± 14.43	91.67 ± 14.43	
0.4	"	75.00 ± 25.00	100.00 ± 0.00	
0.5	"	100.00 ± 0.00		5.50

[a]to attain 100% mortality in a 0.1-ha pond, 1 m deep in 24 hours.

Discussion

Our results are consistent with prior studies. Srivastava and Konar (1966) and Konar (1969) reported an extended LC_{100} for DDVP of 5.0 ppm for adult *C. punctata*. Sreenivasan and Swaminathan (1967) found Phyphanon effective in the range of 10 to 16 ppm. Bleaching powder has been recommended as a piscicide at 25-30 $mg \cdot l^{-1}$, with a detoxification interval of 7-8 days in the pond (CIFRI 1985).

Based on cost as a fish toxicant, the most inexpensive and thus potentially attractive chemical to the fish culturist may be phosphine. Indian-produced phosphine, such as Quickphos and Selphos, was being used by Bangladesh farmers at the time this study was conducted at a cost of $1.00 to treat a 0.1-ha pond (less than the organochlorine compounds). The organophosphorus insecticides were too costly to be attractive to fish culturists. Bleaching powder and rotenone were of moderate cost. However, the detoxification period of

bleaching powder was lengthy and rotenone was not available to the fish culturist in Bangladesh. Local derris derivatives have been tested in Bangladesh on an experimental basis (Ameen et al. 1984). The evaluation was preliminary and costs have not been determined. Saponin derived from tea seeds may also be economically developed in the future as a safe piscicide. These studies should receive high priority.

Acknowledgements

We wish to express appreciation to the officers of FRI and FARS for their support in these studies, especially Dr. M.A. Rahman, Director of the Fisheries Research Institute (FRI) and Dr. M.S. Shah, Chief Scientific Officer of FARS. Mr. Darrell Deppert made many helpful suggestions. Support was provided by FRI and the Danish International Development Agency (DANIDA).

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Manuscript received 8 February 1989 ; accepted 3 May 1989