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Toxicity Of Pesticide Cypermethrine On Freshwater Fish, Nemacheilus Aurius

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ABSTRACT

The toxicity of cypermethrine has been studied to determine the lethal toxicity on a freshwater fish, *Nemacheilus aurius.* 24 hrs LC_{50} values were highest followed by 48, 72 and 96 hrs and LC_{50} values were found to be 0.06, 0.05 and 0.04, 0.03 ppm respectively.

Key Words: Cypermethrine, Nemachilus aurius, Toxicity

INTRODUCTION

Urbanization lead to agricultural development and industrialization due to which various chemical substances have been diffused in the environment causing pollution of all sorts of water reservoirs and degradation of environment has resulted into a serious ecological imbalance. This has always been the case of all developing countries where quality of air and water is continuously deteriorated and the efforts to control the pollution fails Rokade (2012). Determination of acute toxicity is essential for determining sensitivity of the animals to the toxicants and also useful for evaluating the degree of damage to the target organs and the consequent physiological and behavioral disorders. Therefore, the present investigation has been carried out to determine the toxic effects of pyrethroid insecticides cypermethrine on the fresh water fish *N. aurius.*

MATERIAL AND METHODS

The test fish *N. aurius* were collected regularly in live conditions from the river Bohri from Pimpalgoan near Malegaon (near Nashik), Maharashtra (India). Fishes were acclimatized to the laboratory conditions in the glass aquaria containing aerated tap water. The water was renewed every day and the fishes were fed with poultry feed on alternate day. During the experimentation fishes were not fed. The physic-chemical characteristics of the test water such as temperature (24-25^{0}C), water hardness (440 mg/lit), pH (6.4) and

Dissolved oxygen (0.4719 ml/gm/wt/hr) were analyzed during the experiments.

The stock solution of pesticide, cypermethrine was prepared by dissolving a known concentration of this pesticide into the distilled water and required concentrations were made from the stock solution. The acute toxicity as widely accepted for the period of 24, 48, 72 and 96 hrs have been carried out in the present investigation and the observations were made on the percentage mortality of the fish. The LC_{50} values were calculated by using regression equation method of probit analysis (Finney, 1971) the average values have been put in appropriate tables.

RESULTS AND DISCUSSION

The observations made during the acute toxicity experiments, on the *N. aurius* have been tabulated in Table No. 1-6 and Figure 1. The regression for the relation between the doses of cypermethrine and mortality of fish was calculated for LC_{50} values, and found to be 0.06, 0.05 and 0.04, 0.03 ppm for 24, 48, 72 and 96 hrs respectively.

During acute toxicity tests, fish exhibited peculiar reactions after 24 hrs of exposure. The fishes were swimming rapidly with random movements Ganeshwade (2006). At first, the fish surfaced for 10-15 minutes, then slowly became lethargic and settled at the bottom of the aquarium. The fins were paralyzed and the opercular movements gradually slowed down. The fish exhibited acute asphyxiation and occasionally jumped up to gulp air. Sometimes rapid zig zag movements with sudden jerks were observed before an hour to their death.

The mode of toxicity has been studied since 1920. Ellis (1937) showed that many chemicals induced similar precipitation of mucous which filled the space between gill filaments and gill lamellae ultimately affecting the gaseous exchange leading to stasis of blood and death of the fish. Lloyd (1941) and Skidmore (1970) suggested that cytological damage to gills, rather than mucous accumulation caused death by asphyxia.

Jeba kumar et al. (1990) observed the effect of cypermethrine on the organic constituents and its accumulation in the whole fish, *Lepidocephalichthys thermalis.* The result in the present investigation showed percentage of mortality is time and dose dependent.

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Acute toxicity involved the damage to the organisms by the fastest acting mechanism. Similar observations were made by Devi et al. (1972), Kutty (1973), Zitko et al. (1977), Gill et al. (1991), Kanabav and Banna (2001), Joakim et al. (2002) and Dussart and Trigwell (2002).

Mount (1962) described the result of endrine poisoning, in blunt nose minnows as indicative of disorders of the central nervous system, commencing with rapid jerky movements of the body and fins, and increase ventilation rate and sensitivity to external stimulus. The fish then moved to the surface swimming slowly and sometimes backwards and convulsions followed. These increased until equilibrium was lost, but the fish often 'barrel rolled' or spiraled at intervals before respiration eventually ceased.

The behavioral changes in the present investigation may be due to influence of the pesticide cypermethrine and therefore the fish showed rapid movements.

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Table No. 1.

Calculation of log. Dose/probit regression line for some experiments in which mature fish *Nemacheilus aurius* were exposed (24 hrs) to different concentrations of cypermethrine. LC_{50} for 24 hrs.

Sr. No.	Conc. In ppm	No. of animals used	Mortality % (p)	Log +2 X	Emprical probit	Expected probit Y	Working probit Y=yo +kp	Weighting coefficient	W eig W	WX	WY	WX^2	WY^2	WXY	Y_1
	.03	10	0	.47	0.00	--	--	--	--	--	--	--	--	--	--
	.04	10	20	.60	4.16	4.25	4.16	.503	5.03	3.01	20.92	1.80	87.02	12.52	4.2
	.05	10	40	.69	4.75	4.65	4.74	.601	6.01	4.14	28.48	2.85	134.99	19.62	4.6
	.06	10	50	.77	5.00	5.00	5.00	.637	6.37	4.90	31.85	3.77	159.25	24.5	4.9
	.07	10	60	.84	5.25	5.3	5.25	.616	6.16	5.17	32.34	4.34	169.78	27.14	5.3
	.08	10	70	.90	5.52	5.5	5.52	.581	5.81	5.22	32.07	4.69	177.02	28.81	5.6
	.09	10	80	.95	5.84	5.8	5.84	.503	5.03	4.77	29.37	4.53	171.52	27.85	5.8
	.11	10	90	1.04	6.28	6.2	6.2	.336	3.36	3.49	20.83	3.62	129.14	21.63	6.2

ΣWX 30.7 ΣWXY - ẌΣY

Ẍ = ------------------- = ------------- = 0.81 b = -----------------------------

ΣW 37.77 - ẌΣWX

ΣWY 195.86 162.07-(0.81 x 195.86) 3.43

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Ȳ = ------------------- = ------------- = 5.18 = ---------------------------- = --------------- b= 4.63

ΣW 37.77 25.06 x - (0.81x 30.7) 0.74

ΣW= 37.77, ΣWX=30.7, ΣWY=195.86, $ΣWX^2$=25.60, $ΣWY^2$=1028.72, ΣWXY=162.07

Y^1= (Ȳ -bx)+bx
= (5.18-4.63x.81)
+4.63x.6
= 1.43+2.77
= 4.2

Y^1 = 4.6 Y^1 = 4.9 Y^1 = 5.3 Y^1=5.6 Y^1 = 5.8 Y^1 = 6.2

Table No. 2.

Calculation of log. Dose/probit regression line for some experiments in which mature fish *Nemacheilus aurius* were exposed (48 hrs) to different concentrations of cypermethrine. LC_{50} for 24 hrs.

Sr. No.	Conc. In ppm	No. of animals used	Mortality % (p)	Log+2 X	Emprical probit	Expected probit Y	Working probit Y=y0 +kp	Weighting coefficient	Weig W	WX	WY	WX^2	WY^2	WXY	Y^1
	.03	10	10	.47	3.72	3.65	3.72	.302	3.02	1.41	11.23	0.66	41.77	5.24	3.65
	.04	10	30	.60	4.48	4.48	4.48	.558	5.58	3.34	24.99	2.00	111.95	14.96	4.44
	.05	10	50	.69	5.00	5.00	5.00	.637	6.37	4.39	31.85	3.02	159.25	21.95	4.98
	.06	10	60	.77	5.25	5.5	5.24	.581	5.81	4.47	30.44	8.44	159.50	23.42	5.46
	.07	10	80	.84	5.84	5.9	5.83	.471	4.71	3.95	27.45	3.31	160.03	23.02	5.89
	.08	10	90	.90	6.28	6.28	6.27	.370	3.70	3.33	23.19	2.99	145.40	20.87	6.25

ΣWX 20.89 ΣWXY - ẌΣY

Ẍ = ------------------- = ------------- = 0.71 b = ----------------------------

ΣW 29.19 - ẌΣWX

ΣWY 149.19 109.46-(0.71 x 149.15) 3.57

Ȳ = ------------------- = ------------- = 5.10 = ---------------------------- = --------------- b= 6.05

ΣW 29.19 15.42 x - (0.71x 20.89) 0.59

ΣW= 29.19, ΣWX=20.89, ΣWY=149.15, $ΣWX^2$=15.42, $ΣWY^2$=777.90, ΣWXY=109.46

$Y^1 = (\bar{Y} - bx) + bx$

$= (5.10-(6.05x0.71)$

$+6.05x0.47$

$= 0.81+2.84$

$= 3.65$

Y1 = 4.44 $Y^1 = 4.98$ $Y^1 = 5.46$ $Y^1 = 5.89$ $Y^1 = 6.25$

Table No. 3.

Calculation of log. Dose/probit regression line for some experiments in which mature fish *Nemacheilus aurius* were exposed (48 hrs) to different concentrations of cypermethrine.
LC_{50} for 72 hrs.

Sr. No.	Conc. In ppm	No. of animals used	Mortality % (p)	Log+2 X	Emprical probit	Expected probit Y	Working probit Y=yo +kp	Weighting coefficient	Weig W	WX	WY	WX^2	WY^2	WXY	Y^1
	.03	10	30	.47	4.48	4.25	4.50	0.503	5.03	2.36	22.63	1.10	101.83	10.62	4.26
	.04	10	50	.60	5.00	5.00	5.00	0.637	6.37	3.82	31.85	2.29	159.25	19.1	5.01
	.05	10	60	.69	5.25	5.45	5.25	0.601	6.01	4.14	31.55	2.55	165.63	21.73	5.52
	.06	10	80	.77	5.84	5.9	5.83	0.471	4.71	3.62	27.45	2.78	160.03	21.10	5.98
	.07	10	90	.84	6.28	6.28	6.27	0.370	3.70	3.10	23.19	2.60	145.40	19.43	6.38

$\ddot{X} = \frac{\Sigma WX}{\Sigma W} = \frac{17.04}{25.82} = 0.65$ $b = \frac{\Sigma WXY - \ddot{X}\Sigma Y}{- \ddot{X}\Sigma WX}$

$\bar{Y} = \frac{\Sigma WY}{\Sigma W} = \frac{136.67}{25.82} = 5.29$ $= \frac{91.98-(0.65 \times 136.67)}{11.62 - (0.65x\ 17.04)} = \frac{3.15}{0.55}$

b= 5.72

$\Sigma W = 25.82$, $\Sigma WX = 17.04$, $\Sigma WY = 136.67$, $\Sigma WX^2 = 11.62$, $\Sigma WY^2 = 732.14$, $\Sigma WXY = 91.98$

$Y^1 = (\bar{Y} - bx) + bx$

$= (5.29 - 5.72 \times .65)$

$+5.72 \times 0.49$

$= (5.29 – 3.71) + 2.68 = 1.58 + 2.68 = 4.26$

Y1 = 5.01 $Y^1 = 5.52$ $Y^1 = 5.98$ $Y^1 = 6.38$

Table No. 4.

Calculation of log. Dose/probit regression line for some experiments in which mature fish *Nemacheilus aurius* were exposed (96 hrs) to different concentrations of cypermethrine.
LC_{50} for 72 hrs.

Sr. No.	Conc. In ppm	No. of animals used	Mortality % (p)	Log+2 X	Emprical probit	Expected probit Y	Working probit Y=yo +kp	Weighting coefficient	Weig W	WX	WY	WX^2	WY^2	WXY	Y^1
	.03	10	30	.47	4.75	4.74	4.74	0.616	6.16	2.89	29.19	1.35	138.36	13.69	4.65
	.04	10	50	.60	5.00	5.25	5.25	0.601	6.01	3.60	31.55	2.16	165.63	18.9	5.37
	.05	10	60	.69	5.85	5.84	5.84	0.503	5.03	3.47	29.37	2.39	171.52	20.26	5.84
	.06	10	80	.77	6.28	6.27	6.27	0.370	3.70	2.84	23.19	2.18	145.40	17.60	6.30

$$\ddot{X} = \frac{\Sigma WX}{\Sigma W} = \frac{12.80}{20.90} = 0.62 \qquad b = \frac{\Sigma WXY - \ddot{X}\Sigma Y}{- \ddot{X}\Sigma WX}$$

$$\bar{Y} = \frac{\Sigma WY}{\Sigma W} = \frac{113.30}{20.90} = 5.42 \qquad = \frac{70.65 - 0.61 \times 113.30}{8.08 - 0.61 \times 12.80} = \frac{1.54}{0.28}$$

b= 5.5

$\Sigma W = 20.90$, $\Sigma WX = 12.80$, $\Sigma WY = 113.30$, $\Sigma WX^2 = 8.08$, $\Sigma WY^2 = 620.91$, $\Sigma WXY = 70.65$

$Y^1 = (\bar{Y} - bx) + bx$

$= (5.42 - 5.5 \times .61)$

$+5.5 \times 0.47$

$= 2.07 + 2.58$

$= 4.65$

Y1 = 5.01 $\quad Y^1 = 5.52 \quad Y^1 = 5.98 \quad Y^1 = 6.38$

Table No. 5.

Relative toxicity study of *N. aurius* after different hrs. exposure with cypermethrin

Sr. No.	LC_{50} values after different hrs. exposure in ppm			
	24 hrs.	48 hrs.	72 hrs.	96 hrs.
1	0.06	0.05	0.04	0.03

Table No. 6

Relative toxicity of cypermethrin when fish *N. aurius* were exposed to 24 hrs. to 96 hrs.

Hrs. of exposure	Regression equation	LC_{50} + S. E.	Homogenesity Heterogenesity	Fiducial Limit		Relative toxicity
				M_1	M_2	
24	Y = 1.43 + 2.77 X	0.06 ± .22	- 1.71	- 0.387	0.507	1
48	Y = 0.81 + 2.84 X	0.05 ± .16	- 4.35	-00.266	0.316	1.2
72	Y = 0.58 + 2.68 X	0.04 ± .17	- 8.86	- 0.299	0.339	1.5
96	Y = 2.07 + 2.58 X	0.03 ± .21	- 1.62	- 0.394	0.454	2