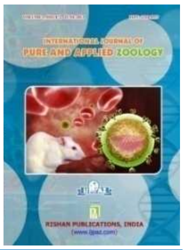
ISSN Print/Online: 2320-9577/2320-9585
INTERNATIONAL JOURNAL OF PURE AND APPLIED ZOOLOGY
Volume 1, Issue 2, June 2013
Available online at: http://www.ijpaz.com
RISHAN PUBLICATIONS



RESEARCH ARTICLE OPEN ACCESS

STUDIES ON THE ACUTE TOXICITY OF PESTICIDES ON THE FRESHWATER FISH *LABEO ROHITA*

K. MUTHUKUMARAVEL[1*], M. SUKUMARAN[2] and O. SATHICK[1]

[1]PG and Research Department of Zoology, Khadir Mohideen College, Adirampattinam 614 701, Tamilnadu, India

[2]Rajah Serfoji Government Arts College, Thanjavur-613 005, Tamilnadu, India

*Corresponding Author Email: kumar_phd_2003@yahoo.co.in, Tel: +91 9791387363

Article History: Received: 04.06.2013, Accepted: 23.06.2013

ABSTRACT

The present study was carried out to investigate the LC_{50} of two different pesticides such as monocrotophos and lambda cyhalothrin on the freshwater fish *Labeo rohita*. Monocrotophos caused 100% mortality of *L. rohita* at 0.0044ppm and 50% mortality (96 hours) at 0.0036 ppm, and for lambda cyhalothrin, the lethal effect was at 0.0029 ppm and LC_{50} at 0.0021 ppm. The LC_{50} values obtained at 24, 48, 72 and 96 hours exposures and the 95% confidence limits for the two pesticides revealed that lambda cyhalothrin showed higher toxicity than monocrotophos. The LC_{50} values of monocrotophos for 24, 48, 72 and 96 hours were 0.0041, 0.0039, 0.0037 and 0.0036 ppm respectively, whereas the LC_{50} value of lambda cyhalothrin for 24, 48, 72 and 96 hours were 0.0026, 0.0024, 0.0022 and 0.0021 ppm, respectively.

Key words: Monocrotophos, lambda cyhalothrin, mortality, *Labeo rohita*.

INTRODUCTION

Indiscriminate use of different pesticides in agriculture to prevent crop damage from pests has been increasing over two decades especially in developing countries (Santhakumar and Balaji, 2000). These pesticides through surface run off reach unrestricted areas like ponds and rivers and alter the physico-chemical properties of water and consequently affecting aquatic organisms (Kamble and Muley, 2000, Bhachandra *et al.*, 2001; Madhab Prasad *et al.*, 2002 and Sindhe *et al.*, 2007).

In assessing the safety level of any poisonous chemical for higher animals, the first task is to determine the acute toxic LC_{50} value, a simple expression of the degree of toxicity that can be understood by toxicologists (Doubois and Geiling, 1959). The increasing awareness of aquatic pollution demands toxicity tests to assess the efficacy of the contaminants and to extrapolate their safe levels permissible in the environment. The median tolerance limit of any pollutant is meant as an elementary guide in the field of toxicology (Ward and Parrish, 1982). Without reference to the median tolerance limit, no information on sublethal effects can be deduced (Patin, 1982). Dermal acute toxicity tests represent an important method for establishing criteria to evaluate water quality and therein to protect the aquatic environments (NAS/NAE, 1972). Acute toxicity studies are generally employed to compare the sensitivities of different species to different potencies of the chemicals and to derive, by using LC_{50} values, environmental concentration of chemicals which could be considered 'safe'.

Toxicity data for a variety of pesticides such as organophospate, organochlorine, carbamide and pyrethroid pesticides have been reported for number of fish species by various authors (Anees, 1975; Arunachalam and Palanichamy 1982; Arunachalam *et al*., 1980; Baskaran *et al*., 1989; Roy and Dutta Munshi, 1988; Singh *et al*., 1981; Malla Reddy and Basha Mohideen, 1989; Gurusamy and Ramdoss, 2000; Sapna Shrivastava, 2002; Nishar Shailkh and Yeragi, 2004 and Visvanthan *et al*., 2009). Variations in LC_{50} if any, under different energy balance should reflect on the nutritional status of the animal. This would help to assess the productivity of the aquatic medium concerned and to take appropriate corrective measures.The present work has been carried out to study the lethal concentration 50% (LC_{50}) of pesticides monocrotophos and lambda cyhalothrin on the freshwater fish *Labeo rohita*.

MATERIALS AND METHODS

Fish Acclimatization

The freshwater healthy fish, *L. rohita* of the weight (10 ± 1g) and length (8 ± 0.5 cm**)** were selected for the experiment and were collected from Katherasan Aquafarm near Thanjavur. Fish were screened for any pathogenic infections. Glass aquaria were washed with 1% $KMnO_4$ to avoid fungal contamination and then sun dried. Healthy fishes were then transferred to glass aquaria (35×20×20 cm) containing dechlorinated tap water (Temperature 28 ± 2°C; total hardness 518 ± 23 mg/l; dissolved oxygen 5.6 ± 0.2 mg/l; salinity 1.2 ± 0.13 ppt and pH 7.8 ± 0.04). Fish were acclimated to laboratory conditions for 10 to 15 days prior to experimentation. They were regularly fed with commercial food *ad libitum* and the medium (tap water) was changed daily to remove faeces and food remnants.

Acute toxicity test

Toxicity tests were conducted in accordance with standard methods (APHA, 1992). Stock solution of monocrotophos with a concentration of 1 ml per litre (equivalent to 1 ppt) was prepared in distilled water and different dilutions were prepared by adding required amount of distilled water. The stock solution of lambda cyhalothrin with a concentration of 1 ml per litre was also prepared in distilled water and the desired degree of concentrations was prepared. Based on the progressive bisection of intervals on a logarithmic scale, log concentrations were fixed after conducting the range finding test. The fish were starved for 24 hours prior to their use in the experiments as recommended by storage to avoid any interference in the toxicity of pesticides by excretory products. After the addition of the toxicant into the test tank with 10 litres of water having twenty fish, mortality was recorded after 24, 48, 72 and 96 hours. Five replicates were maintained simultaneously.

Per cent mortality was calculated and the values were transferred into probit scale. Probit analysis was carried out as suggested by Finney (1971). Regression lines of probit against logarithmic transformations of concentrations were made. Confidential limits (upper and lower) of the regression line with chi-square test were calculated by a computerized programme for Finney's (1971) probit analysis.

RESULTS AND DISCUSSION

Monocrotophos caused 100% mortality of *L. rohita* at 0.0044 ppm and 50% mortality (96 hours) at 0.0036 ppm, and for lambda cyhalothrin, the lethal effect was at 0.0029 ppm and LC_{50} at 0.0021 ppm. The LC_{50} values obtained at 24, 48, 72 and 96 hours exposures and the 95% confidence limits for the two pesticides revealed that lambda cyhalothrin showed higher toxicity than monocrotophos. The LC_{50} values of monocrotophos for 24, 48, 72 and 96 hours were 0.0041, 0.0039, 0.0037 and 0.0036 ppm respectively (Table 1; Figures 1-4), whereas the LC_{50} value of lambda cyhalothrin for 24, 48, 72 and 96 hours were 0.0026, 0.0024, 0.0022 and 0.0021 ppm, respectively (Table 2 and Figures 5-8).

Table 1. Per cent mortality of *Labeo rohita* exposed to different concentrations of monocrotophos for different periods.

Hours of Exposure	LC_{50}	L.C.L	U.C.L	Regression Equation	Calculated χ^2 value	Table χ^2 value
24	0.004084	0.004003	0.004167	Y= 32.08157 + 11.3365 X	8.2512	12.59
48	0.003870	0.003796	0.003946	Y= 33.42346 + 11.78303 X	9.0221	11.07
72	0.003726	0.003662	0.003791	Y= 37.45153 + 13.36139 X	3.5032	11.07
96	0.003556	0.003502	0.003611	Y= 42.9766 + 15.50699 X	6.7556	11.07

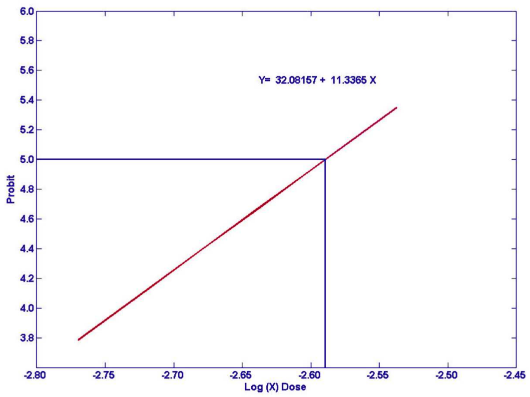


Figure 1. Regression line (based on Probit analysis) of log concentration of pesticide monocrotophos Vs Per cent mortality of *L. rohita* for 24 hours.

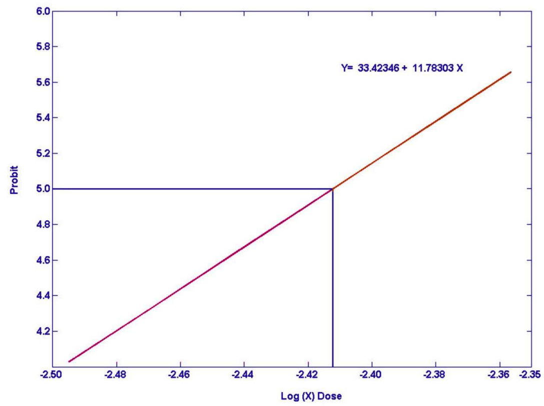


Figure 2. Regression line (based on Probit analysis) of log concentration of pesticide monocrotophos Vs Per cent mortality of *L. rohita* for 48 Hours.

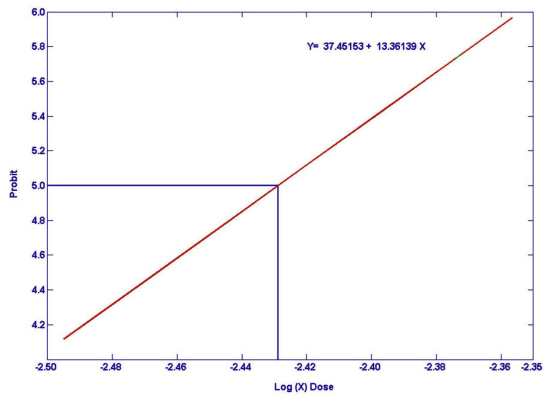


Figure 3. Regression line (based on Probit analysis) of log concentration of pesticide monocrotophos Vs Per cent mortality of *L. rohita* for 72 hours.

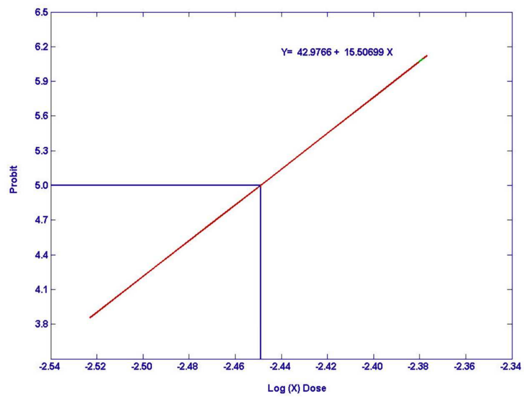


Figure 4. Regression line (based on Probit analysis) of log concentration of pesticide monocrotophos Vs Per cent mortality of *L. rohita* for 96 hours.

Table 2. Per cent mortality of *Labeo rohita* exposed to different concentrations of lambda cyhalothrin for different periods.

Hours of Exposure	LC_{50}	L.C.L	U.C.L	Regression Equation	Calculated χ^2 value	Table χ^2 value
24	0.002575	0.002474	0.002679	Y= 22.44465 + 6.737374 X	5.6685	11.07
48	0.002370	0.002286	0.002457	Y= 21.49032 + 6.281464 X	8.8858	12.59
72	0.002156	0.002023	0.002298	Y= 24.59749 + 7.350035 X	17.6868	12.59
96	0.002030	0.001967	0.002095	Y= 23.85884 + 7.004488 X	8.9140	12.59

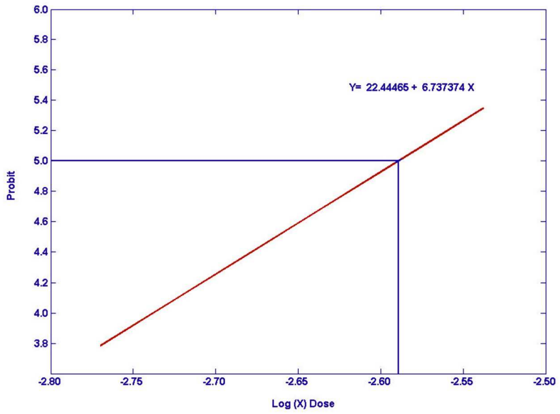


Figure 5. Regression line (based on Probit analysis) of log concentration of pesticide Lambda cyhalothrin Vs Per cent mortality of *L. rohita* for 24 hours

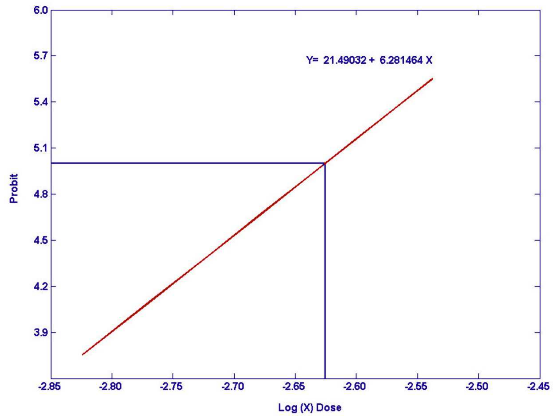


Figure 6. Regression line (based on Probit analysis) of log concentration of pesticide Lambda cyhalothrin Vs Per cent mortality of *L. rohita* for 48 hours

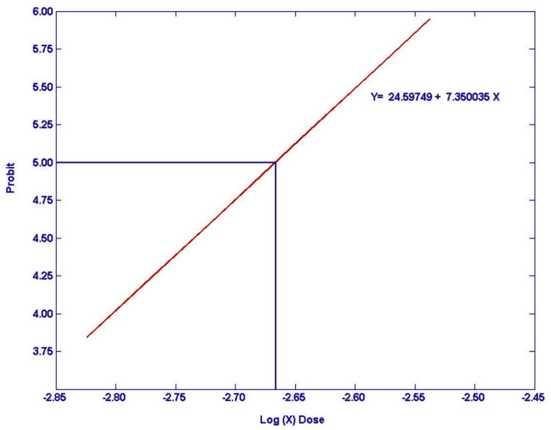


Figure 7. Regression line (based on Probit analysis) of log concentration of pesticide Lambda cyhalothrin Vs Per cent mortality of *L. rohita* for 72 hours

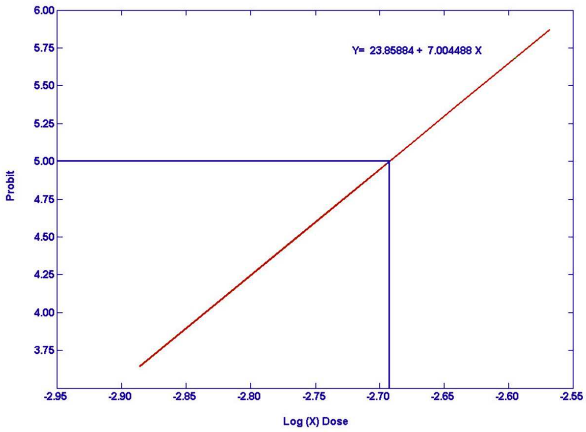


Figure 8. Regression line (based on Probit analysis) of log concentration of pesticide Lambda cyhalothrin Vs Per cent mortality of *L. rohita* for 96 hours

L. rohita was silvery white in body in the control group throughout the experiment. The body colour changed from original silvery white to dark colour in pesticide treated fish. The fish maintained in freshwater behaved normal as usual. But when the fish was exposed to pesticides monocrotophos and lambda cyhalothrin, erratic swimming, abnormal posture, disbalance, sluggishness, imbalance in posture, increase in surface activity, opercular movement, gradual loss of equilibrium and spreading of excess of mucus all over the surface of the body were observed.

A survey of LC_{50} values of different pesticides to the fish for different periods of exposure reveals the occurrence of a wide differences between duration of exposure and types of fishes (Macek and Mc Allister, 1970; Holden, 1972; Carter and Graves, 1973; Bakthavathasalam 1980; Koundinya and Ramamurthi, 1980; Padmini, 1980; Rani *et al.*, 1990; Dhanalakshmi, 1991; Sadhu, 1993; Pickering and Henderson, 1966; Santhakumar and Balaji, 2000; Mathivanan, 2004 and Ramasamy *et al*., 2007). Changes in body colour have been reported in *Anabas testudineus* after exposure to monocrotophos (Santhakumar and Balaji, 2000), *C. punctatus* to organophosphorus (Sandhu, 1993) and *Cyprinus carpio* to ammonia stress (Israeli-weinstein and Kimmel, 1998). The behavioural changes are considered directly related to complex physiological responses and have often been used as a sensitive indicator of stress (Little and Finger, 1990).

Fish exposed to sub lethal concentrations of pesticides irregular, erratic and darting movements with imbalanced swimming activity and attempt to jump out of the toxic medium were observed. Similar behaviour patterns were observed in fish, trout and *L. rohita* exposed to fenvelrate (Murthy, 1987). Increased opercular movements, loss of equilibrium, erratic swimming and jerky movement and mucous secretion all over the body were observed in *Heteropneustes fossilis* after exposure to rogor and endosulphan pesticides (Borah and Yadav, 1995). Erratic swimming, imbalance in posture, increased surfacing activity with gradual decrease in opercular movement, loss in equilibrium, excess of mucus all over the body surface followed by sluggishness and death of *A. testudineus* after exposure to monocrotophos was reported by Santhakumar and Balaji (2000).

Many workers have observed erratic swimming, equilibrium loss and surfacing phenomenon in the fish following pesticide exposure. Surfacing phenomenon shown by the fish might be to gulp maximum possible air to ease the tension. Rao and Rao (1987) also observed this phenomenon in the fish, *Channa punctatus* exposed to two different pesticides viz., carbaryl and phenthoate. In relation to this they also reported that the surfacing phenomenon was due to hypoxic condition of the fish. Increased opercular movements were seen in the fish, *L. rohita* exposed to pesticides, which was in accordance to the report put forth by Amita kiran and Jha (2009) in *Clarias batrachus* exposed to herbicide, herboclin. The rapid opercular movements may be due to accumulation of mucous over gill due to the toxicant (Sadhu, 1993; Sabita and Yadav, 1995 and Jagadeesan and Vijayalakshimi, 1999). Similar findings were observed by Prasanth *et al.* (2005), when freshwater fish *C. mrigala* exposed to cypermenthrin. The fish *L. rohita* exhibited irregular, erratic darting movements with imbalanced swimming activity. Occasionally the fish tried to jump out of the toxic medium, which shows the avoidance behaviour of the fish to the toxicant. Similar behavioural patterns were observed in *L. rohita* exposed to endosulfan (Shivakumar and David, 2004).

The change of body colour, behavioural changes such as irregular swimming movements, loss of equilibrium, restlessness and excess secretion of mucous suggest that *L. rohita* has undergone chemical stress when exposed to pesticide and the present study could be taken as an indicator of aquatic pollution.

REFERENCES

Amita Krian and Jha, A.K. 2009. Acute toxicity and behavioural responses of herbicide (Herboclin) to the fish *Clarias batrachus* (Linn). *Indian J. Environ. Ecoplan.*, **16**(1): 185-188.

Anees, M.A., 1975. Acute toxicity of four organophosphorus insecticides to freshwater teleost Channa *punctatus*. *Park. J. Zoo.*, **7**: 135.

APHA (American Public Health Association), 1992. Standard Methods of Water and Wastewater. 18th ed. American Public Health Association, American Water Works Association, Water Environment Federation publication. APHA, Washington D.C.

Arunachalam, S. and Palanichamy, S. 1982. Sublethal effects of carboryl on surfacing behaviour and food utilization in the air breathing fish *Macropods cupanus. Physiol. Behav.*, **29**: 23-27.

Arunachalam, S.K., Jayalakshmi and Aboobucker, S. 1980. Toxic and sublethal effects of carboryl on freshwater catfish *Mystus vittatus*. *Arch. Environ. Contam. Toxicol.*, **9**: 307-316.

Bakthavathsalam, R., 1980. Toxicity and physiological impact of three selected pesticides of an air-breathing fish, *Anabas testudineus* (Bloch). *Ph.D. Thesis*, Annamalai University, Tamil Nadu, India.

Baskaran, P., Palanichamy S. and Balasubramanian, M.P. 1989. Effect of pesticides on protein metabolism in *Mystus vittatus. J. Ecobiol.*, **1**(2): 90-97.

Bhalchandra, B., Wayker and Lornte, V.S. 2001. Acute toxicity of pesticides carbaryl and endosulfan to fresh water bialves, *Parreysia cyclindrica*. *Poll. Res.*, **20**(1): 25-29.

Borah and Yadav, 1995. Bioassay and toxicity of two pesticides, Rogar and Endosulfan to the air breathing fish *Heteropneustes fossilis* with special references to behaviour. *Poll. Res.*, **14**(4): 435-438.

Carter, F.L. and Graves, J.B. 1973. Measuring effects of insecticides on aquatic animals. *Lousiana Artic.* 16-14.

Dhanalakshmi, S., 1991. Synergistic toxicity and effects of dimecroncuman on oxygen consumption and haematological parameters of freshwater teleost, *Sarotherodon mossambicus* (Peters). *M.Phil. Thesis,* Bharathiar University, Coimbatore, Tamil Nadu, India.

Dubois, K.P and Geiling, E.M.K. 1959. Text book of Toxicology. Oxford University Press. Oxford. pp.302.

Finney, D.J., 1971. Probit Analysis. Cambridge Univ. Press, London.

Gurusamy, K. and Ramadoss, V. 2000. Impact of DDT on oxygen consumption and opercular activity of *Lepidocephalichthys thermalis*. *J. Ecotoxicol. Environ. Monit.*, **10**(4): 239-248.

Holden, A.V., 1972**.** The effects of pesticides on life in freshwater. *Proc. Royal Soc., Lond. B.*, **180**: 383-394.

Israeli-Weinstein, D. and Kimmel, E. 1998. Behavioural response of carp, *Cyprinus carpio* to ammonia stress. *Aquaculture,* **165**(1): 81-93.

Jagadeesan, G. and Vijayalakshmi, S. 1999. Alterations in the behaviour patterns in *Labeo rohita* (Ham.) fingerlings induced by mercury. *Indian J. Environ. Toxicol.,* **9**(1): 50-52.

Kamble, G.B. and Muley, D.V. 2000. Effect of acute exposure of endosulfan and chlorpyrifos on the biochemical composition of the fresh water fish, *Sarotherodon mossambicus. Indian J. Environ. Sci*., **4**(1): 97-102.

Koundinya, P.R. and Ramamurthi, R. 1980. Toxicity of sumithion and sevin to the freshwater fish, *Sarotherodon mossambicus* (Peters). *Curr. Sci.*, **49**(22): 875-876.

Little, E.E. and Finger, S.E. 1990. Swimming behaviour as an indicator of sublethal toxicity in fish. *Environ. Toxicol. Chem,* **9**: 13-19.

Macek, K.J. and Mc Allister, W.A. 1970. Insecticide susceptibility of some common fish family representatives. *Trans. Amer. Fish. Soc.*, **99**(1): 20-27.

Madhab Prasad, Bandyopadhyay and Ajit Kumar, Aditya, 2002. Xenobiotic impact on sensitivity in *Anabas testudineus* (Bloch). *J. Ecobiol.*, **14**(2):117-124.

Malla Reddy, P. and Bashamohideen, M.D. 1989. Toxic impact of fenvalerate on protein metabolism in the branchial tissue of a fish *Cyprinus carpio. Curr. Sci.*, **57**: 211-212.

Mathivanan, R., 2004. Effects of sublethal concentration of quinophos on selected respiratory and biochemical parameters in the fresh water fish *Oreochromis mossambicus. J. Ecotoxicol. Environ. Monit.,* **14**(1): 57-64.

Murthy, A.S., 1987. Sublethal effect of pesticides on fish. *Toxicity of Pesticide to fish*. **2**: 55-100.

NAS/NAE (National Academy of sciences/ National Academy of Engineering, 1972. Water quality criteria. EPA-R3-033, 1971. Washington, **24**: 1701.

Nisar Shaikh and Yeragi, S.G. 2004. Effect of Rogor 30E (Organophosphate) on muscle protein in the fresh water fish *Lepidocephalecthyes thermalis*. *J. Ecotoxicol. Environ. Morit.,* **14**(3): 233-235.

Padmini, N., 1980. Toxicity and effects of pesticide sevin on blood free amino acids level of *Tilapia mossambica* (Peters). M.Sc. Dissertation, University of Madras, Tamil Nadu, India.

Patin, S.A., 1982. Effect of pollutants on cultured unicellular marine algae. In: Pollution and the Biological Resources of the Oceans. (Ed. S.A.Patin), Butterworth Scientific Co., London. pp. 87.

Pickering, Q.H. and Henderson, C. 1966. The acute toxicity of some pesticides to fish. *Ohio. J. Sci*., **66**(5): 508 -513.

Prasanth, M.S., David, M. and Mathed, S.G. 2005. Behavioural changes in fresh water fish, *Cirrhinus mrigala* (Hamilton) exposed to cypermethrin. *J. Environ. Biol.,* **26**(1): 141-144.

Ramasamy, P. K., Jeyaraj, R., Rajkumar David, A.J. and Ramaswamy, M. 2007. Toxicity of an organophosphorus pesticide, quinalphos to the catfish, *Mystus vittatus*. *J. Ecotoxicol. Environ. Monit.*, **17**(4): 391-396.

Rani, S., Shaik Dawood, A. and Ramasamy, M. 1990. Toxicity of a carbamate fungicide, cuman to an edible, freshwater fish, *Sarotherodon mossambicus* (Peters). *J. Aquor*., **3**(1): 29-36.

Rao, S and Rao, C. 1987. Independent and combined action of carbaryl and phenltoate on snake head *Channa punctatus* (Bloch). *Curr. Sci.*, **56**(7):331-332.

Roy, P.K. and Datta Munshi, J.S. 1988. Oxygen consumption and ventilation rate of fresh water major carp, *Cirrhinus mrigala* (Ham). In fresh and Malathion treated waters, *J. Environ. Physiol.,* **9**(1): 05-13.

Sabita, B. and Yadav, R.N.S. 1995. Static bioassay and toxicity of two pesticides, roger and endosulfan to the air breathing fish, *Heteropneustes fossilis* with special references to behavior. *Poll. Res.*, **14**(4): 435-438.

Sadhu, D.N., 1993. Toxicity of an organophosphorous insecticide monocil to the air breathing fish, *Channa punctuatus*. *J. Ecotoxicol. Environ. Monit.,* **3**: 133-136.

Santhakumar, M. and Balaji, M. 2000. Acute toxicity of an organophosphorus insecticide monocrotophos and its effects on behaviour of an air-breething fish, *Anabas testudineus* (Bloch). *J. Environ. Biol.,* **21**(2): 121-123.

Sapna Shrivasatava, Sudha Singh and Keerty Shrivastava, 2002. Effect of carbaryl on glucose content in the brain of *Heteropneustes fossilis J. Ecotoxicol. Environ. Monit*., **12**(3): 205-208.

Shivakumar, R. and David, M. 2004. Endosulfan induced behavioural changes in the fresh water fish, *Cyprinus carpio*. *J. Ecotoxicol. Environ. Monit.*, **14**(1): 65-69.

Sindhe, S.C.S., Indira Pala and Butchiram, M.S. 2007. Toxicity and behavioural changes in the fresh water fish, *Labeo rohita* exposed to Zirum. *J. Ecotoxicol. Environ. Monit.*, **17**(6): 537-542.

Singh, D.N., Tyagi, R.K. and Panwar, R.S. 1981. Toxicity of some organobiocides to a fish *Cyprinus carpio* var communis. *J. Environ. Physiol.*, **2**(3): 41-46.

Visvanathan, P., Maruthanayagam, C. and Govindaraju, M. 2009. Effect of malathion and endosulfan on biochemical changes in *Channa punctatus*. *J. Ecotoxicol. Environ. Monit.*, **19**(3): 251-257.

Ward, G.S. and Parrish, P.R. 1982. Manual of methods in Aquatic Environment Research. Part 6 Toxicity tests. *FAO. Fish Tech. Pub.*, **185**: 23.

Cite this article as:

Muthukumaravel, K., Sukumaran, M. and Sathick, O. 2013. Studies on the acute toxicity of pesticides on the freshwater fish *Labeo rohita. J. Pure Appl. Zool.*, 1(1): 185-192.