International Research Journal of Biological Sciences _____ ISSN 2278-3202
Vol. **7(10),** 1-5, October **(2018)** *Int. Res. J. Biological Sci.*

Response of an ornamental fish exposed to Acephate and Carbendazim

Susanta Nath[1*], Pritam Paul[2], Santanu Mondal[2] and Rahul Podder[1]
[1]Government General Degree College Singur-712 409, West Bengal, India
[2]Bidhannagar College EB-2, Sector-1, Salt Lake, Kolkata-700 064, WB, India
nathsusanta2012@gmail.com

Available online at: www.isca.in, www.isca.me
Received 15th May 2018, revised 17th September 2018, accepted 2nd October 2018

Abstract

An acute toxicity test was performed by using Acephate, an organophosphate and Carbendazim insecticide on Poecilia reticulata commonly known as Guppy fish. This fish was selected due to it's lervicidal property to control mosquito as well as easy availability in market. Fish were exposed to the Acephate and studied in a static renewal bioassay for different hours and $LC_{10,}$ LC_{50} and LC_{90} were estimated respectively. LC_{50} was calculated 0.894mg.l^{-1} for 96hr of exposure which was highest 2.705mg.l^{-1} at 24hr. Whereas, lethal concentrations were measured for fish exposed to Carbendazim for different hours and LC_{50} was calculated 1.866ppm for 96hr of exposure which was highest 3.056ppm at 24hr. The study revealed a significant effect of the used insecticide on the normal behaviors and lifespan of this beneficial fish.

Keywords: Acephate, Carbendazim, Guppy fish, $LC_{50,}$ acute toxicity.

Introduction

In India since Green Revolution, there are lots of improvement in agriculture production. With such improvement, different pesticides as well as fungicides are used regularly which are severed in their action due to tendency of bio-magnification. Chemical pesticides are regularly used to control the pest in agricultural field. These pesticides effect adversely and interfere various hormonal pathway in the body[1]. Fishes are highly affected in Chronic exposure to low levels of pesticides than acute poisoning. In most cases low doses of such pesticides are enough to kill fish, decrease the fish population and change the behavior and physiology which ultimately affect the reproductive pattern of fish and other aquatic organisms[2]. Pesticides and such chemicals are originated from human activity as well as during agricultural practices and discharged directly or indirectly into the water sources. Through food chain such pesticides enter into the trophic levels. Even low concentrations of pesticides hold up the functions of sex hormones leading to unusual sexual development, sex ratio and mating behavior and also interfere with other hormonal processes like thyroid function and bone development[3]. Experimental exposure of fish to different pesticides has been revealed to depress protein values in brain, gills, muscles, kidney and liver due to stress and alteration of metabolic activity[4]. Faheem and Lone has been studied the acute toxicity of bisphenol-A on *Cirrhinus mrigala* fingerlings and observed altered behavioral pattern including loss of balance[5]. It was also reported that after entering into the environment pesticides can be flown by different agents like air, water and carried through the food chain[6,7].

Thus pesticides which are released into the aquatic ecosystem showed deteriorating effect on fish and eventually to man[8].

Moreover water quality characteristics also found to influence by the toxicity of the carbamates. Whereas, different species of fish responded the acute toxicity of the organic phosphorus insecticides with variation[9,10]. Among the aquatic organisms, fishes are mostly affected by these pollutants and are considered as to be the most pertinent organism for measuring the pollution in the water bodies[11,12]. *Poecilia reticulata* is one of the common ornamented fish found abundantly in India. Available data related to the effect of pesticides on the fish were measure. Here an attempt has been made to observe the effect of Acephate and bioassay was used to calculate LC_{50} value of *Poecilia reticulata.*

Materials and methods

Poecilia reticulata commonly known as Guppy fish were obtained from the market near Kolkata. Fishes were kept in the aquarium (24inx18inx18in) containing 40lts of water and acclimatized for 1 week in the Department of Zoology, Bidhannagar College. The healthy fish those showed active movement were only used for the experiment. Only female fish were selected due to easy availability in the market during the experiment. Average weight and length of the selected fish were 0.896 ± 0.056gm (S E) and 4.06 ± 0.142cm respectively.

Carbendazim 50% WP is used antifungal chemical in different crops and ornamental plants. It is used as a seed dresser. It is not toxic to bees. Whereas, insecticide namely Acephate 75% s.p was selected for the experiment due to it's regular use in the villages of West Bengal. It is an Organophosphate insecticide and it's chemical composition is O,S-Dimethylacetylphosphor amidothioate. Acephate is an organophosphate insecticide and has low toxicity in man, is used as both contact and systemic

pesticide against sucking and chewing insects of sugarcane, tobacco, chillies, cotton, fruits, vegetables, and cereals.

Short term toxicity test had been conducted separately for the estimation of lethality of Carbendazim and Acephate to the test specimens. LC_{10}, LC_{50} and LC_{90} were measured during 24, 48, 72 and 96hours duration. A batch of 10 adult disease free laboratory acclimated female healthy fish were released in aquaria (15in×12in×4in) containing 3lt of water. For the experiment of 96hours five such setups were prepared separately and doses of Carbendazim and Acephate were dissolved. Each experiment was conducted in triplicate. Fish were released and different concentrations of studied chemicals were added to respective aquaria and mixed thoroughly. The specific doses had been determined by trial and error. Fish status and behavior, along with water DO_2 (2.41±0.137ppm), free CO_2 (8.62±0.457ppm), Hardness (207.9±2.85ppm) and ammonia (3.33±0.33) were monitored throughout the test. The water was changed every 24h. LC values for the respective time intervals were determined by probit analysis with the help of software probit EPA analysis Version 1.5[13,14].

Results and discussion

In this study, the toxicity of Acephate and Carbendazim was displayed to be time and dose dependent. The degree of correlation (r^2) were observed significant (P<0.01) along with positive regression between exposure time and different LC values.

Poecilia reticulata exposed to various concentrations of acephate for 24, 48, 72 and 96h has been depicted in Table-1. The LC_{50} values at the different exposures were 2.705ppm at 24h, 2.078ppm at 48h, 1.788ppm at 72h and 0.894ppm at 96h, the LC_{10}, LC_{50} and LC_{90} values, their upper and lower confidence limits also presented. Similarly, *P. reticulata* also exposed to various concentrations of Carbendazim for 24, 48, 72 and 96h. (Table-2).

The LC_{50} values at the different exposures were 3.056ppm at 24h, 1.888ppm at 48h, 1.777ppm at 72h and 1.866ppm at 96h. The LC_{10}, LC_{50} and LC_{90} values, their upper and lower confidence limits also presented.

Table-1: Acute Toxicity Test showing Tolerance of *Poecilia reticulate* to Acephate.

Exposure Period	LC_{10} ppm	LC_{50} ppm	LC_{90} ppm	95% Confidence Limit for LC_{50}		Regression Equation	r^2	Heterogencity	t-value
				Lower Limit	Upper Limit				
24h	1.928	2.705	3.796	2.344	3.024	y=1.235+8.709x	0.984	1.732	13.56*
48h	1.316	2.078	3.28	1.673	2.402	y=2.946+6.463x	0.9809	1.513	12.40*
72h	1.084	1.788	2.949	1.457	2.115	y=3.511+5.897x	0.9837	1.913	13.45*
96h	0.542	0.894	1.474	0.729	1.058	y=5.278+5.897x	0.984	1.913	13.58*

*Significant P<0.01.

Table-2: Acute Toxicity Test showing Tolerance of *Poecilia reticulate* to Carbendazim.

Exposure Period	LC_{10} ppm	LC_{50} ppm	LC_{90} ppm	95% Confidence Limit for LC_{50}		Regression Equation	r^2	Heterogenecity	t-value
				Lower Limit	Upper Limit				
24h	2.048	3.056	4.563	2.508	3.576	Y=1.425+7.365x	0.976	1.363	11.04*
48h	0.629	1.888	5.670	1.122	2.656	Y=4.259+2.683x	0.981	2.781	12.45*
72h	0.472	1.777	6.692	0.985	2.708	Y=4.44+2.23x	0.97	4.645	9.84*
96h	0.903	1.866	3.853	1.33	2.46	Y=3.897+4.068x	0.931	4.283	6.36*

*Significant P<0.01.

Several studies were conducted so far related to effects of pesticides on different fish species. To our knowledge only few studies exist regarding the LC values of Acephate on *Poecilia reticulata*. Tolerance limit of an organism like fish indicates the relative toxicity and sensitivity of the fish against different chemicals. Such tolerance is usually measured in term and of the level of lethal factor as well as time of exposure. Toxic chemicals have potency to induce harmful effects on an organism. Toxicity of a chemical also depend upon concentration of the chemical used and the exposure period of the animal[15]. Fish and other aquatic organisms are very sensitive to pesticides. Drastic fish killing due to sudden contamination of water sources are of deep concern, but relatively infrequent incidences[3]. Sublethal concentration of pesticides though not cause instant death, but can interrupt the biology of the organisms in various ways and can put impact on their survival. Mastan and Shaffi have been reported noticeable changes in the brain tissue under both chronic and acute exposure of Oraganophosphate pesticides[16].

It was noticed that microscopic changes were occurred in the ovigerous lamellae of *Heteropneustus fossilis* exposed to organophosphate pesticide Malathion[17]. Moreover, Mohan has been reported that weight and growth of ovary were reduced when fish were exposed to organophosphate which reflected the disturbance in the hormonal balance[18].

Organophosphorous pesticides are regularly used against pest because of their high insecticidal property and low toxic to mammal, less persistence and rapid biodegradability. But this pesticide affects non-target organisms either directly or indirectly, including larvivorous fish of paddy field, leads to the decrement of larvivorous potentiality[19,20]. Gonadosomatic index of *Cyprinus carpio communis* was directly proportional to the concentration and period of exposure to Organophosphate[21]. Most toxic pesticide for vertebrate is organophosphate. It inhibits cholinesterase activity essential for transmission of nerve impulse[22]. The toxicity tolerance values may vary in different size, weight and age groups of the organism in a stable environmental condition. Study also revealed that effect of doses also changed with the period of exposure as was observed in cases of other fish[23]. LC value also differ from species to species for the same toxicant and also been influenced by the size, age, sex and the nutrient provided[24-26].

To know the effect of any pesticide on aquatic as well as terrestrial fauna, it is essential to know the sublethal concentrations, those effect the fish. As a pollutant pesticides affect the fish and altered the behavior and bioaccumulation of such pesticides take place in the body of fish.

Carbendazim is a commonly used fungicide in West Bengal. It is mainly used in vegetable and flowering plants cultivation. This fungicide have carcinogenic property, along with reproductive and developmental toxicity and also neurotoxic to human[27]. The toxic effects of a chemical may include Both lethal and sublethal concentrations of toxic chemical may alter pattern of reproduction, development, growth rate, biochemistry, histophysiology as well as behavior toxicity depend upon the concentration and period of exposure[15,28]. Our present study revealed that fish exposed to Carbendazim for various concentrations and period have been shown variation in mortality. With the increase in the exposure period low concentration of fungicide became more effective than higher concentration as was observed in other fish[23,24]. In the present study, female fish with almost similar weight were selected and they were exposed to different doses of Carbendazim. It was reported that LC_{50} of this fungicide for *Daphnia magna* was 91µg.l^{-1}, 0.007-0.56ppm for *Ictalurus punctatus*, 0.1-1.8ppm for *Oncorhynchus sp*, and more than 3.2ppm for *Lepomis macrochirus*[29,30]. This fungicide was not harmful for Prussian carp at lower doses between 0.001 and 0.006ppm but its effects on ecosystems is insufficient since Carbendazim is highly toxic to aquatic ecosystem[31].

The effect of any pesticide on fish is determined by measuring sublethal concentrations of that pesticide. In most cases pesticides act as pollutant and altered the behavior of fish and bioaccumulation of such pesticides take place in the body of the exposed organisms. The study related to the effect of carbendazim on different fish species are inconclusive. This experiment confirmed the response of fish to different concentration of this chemical used. It is required to conduct further studies to determine the long term effects on fish exposure to various Carbendazim concentrations.

Conclusion

Poecilia reticulata commonly known as Guppy fish was exposed to Acephate, an organophosphate and Carbendazim insecticides for acute toxicity test and $LC_{10,}$ LC_{50} and LC_{90} were estimated respectively. LC_{50} was calculated 0.894mg.l^{-1} for 96hr of exposure to Acephate, which was highest 2.705mg.l^{-1} at 24hr. Whereas, lethal concentrations were measured for fish exposed to Carbendazim for different hours and LC_{50} was calculated 1.866ppm for 96hr of exposure which was highest 3.056ppm at 24hr. The study revealed a significant effect of these insecticides on the lifespan of this beneficial ornamental fish.

Acknowledgement

Authors are thankful to the Head of the Post Graduate Department of Zoology and Principal, Bidhannagar College for providing laboratory facilities during this work.

References

1. Khan M.Z. and Law F.C. (2005). Adverse effects of pesticides and related chemicals on enzyme and hormone systems of fish, amphibians and reptiles: a review. *Proceedings of the Pakistan Academy of Sciences*, 42(4), 315-323.

2. Kegley S., Neumeister L. and Martin T. (1999). Disrupting the balance: ecological impacts of pesticides in California. *Disrupting the balance: ecological impacts of pesticides in California*. Pesticide Action Network.

3. Ewing R.D. (1999). Diminishing Returns : Salmon Decline and Pesticides. Funded by the Oregon Pesticide Education Network, Biotech Research and Consulting Inc., Corvallis, OR, 55. http://lcrisweb.com/stream/pesticide-fisheffects.htm.2011.

4. Tilak K.S., Rao Janardhana and Jhansi L. (1991). Effect of pesticides mixed in different ratios to the freshwater Labeo rohita. *J. Ecotoxicol. Environ. Monit.*, 1, 49-52.

5. Faheem M. and Lone K.P. (2013). Acute toxicity and Behavioral response of *Cirrhinus mrigala* fingerlings to Bisphenol-A. *International J. Open Scientific Research.*, 1(6), 28-37.

6. Weber J.B. (1977). The pesticide scorecard. *Environmental Science & Technology*, 11(8), 756-761.

7. Farmer W.J., Igue K., Spencer W.F. and Martin J.P. (1972). Volatility of Organochlorine Insecticides from Soil: I. Effect of Concentration, Temperature, Air Flow Rate, and Vapor Pressure 1. *Soil Science Society of America Journal*, 36(3), 443-447.

8. Roy B. and Nath S. (2011). Some haematological investigations on *Oreochromis niloticus* (Trewavas) following exposure to Thiamethoxam. *Acta Zool. Lit.*, 21(4), 301-305.

9. Pickering Q.H., Henderson C. and Lemke A.E. (1962). The toxicity of organic phosphorus insecticides to different species of warmwater fishes. *Transactions of the American Fisheries Society*, 91(2), 175-184.

10. Pickering Q.H. and Henderson C. (1966). The Acute Toxicity of Some Pesticides to Fish. *Ohio J. Sci.*, 66(5), 508-513.

11. Francis S., Mohan K.G. and Oommen V. (2002). Influence of steroid hormones on plasma proteins in fresh water Tilapia *Oreochromis mossambicus*. *Indian J. Exp.Biol.*, 40, 1206-1208.

12. Van der Oost R., Beyer J. and Vermeulen N.P. (2003). Fish bioaccumulation and biomarkers in environmental risk assessment: a review. *Environmental toxicology and pharmacology*, 13(2), 57-149.

13. Finney D.J. (2009). Probit analysis. Cambridge University Press, London, 333-360. ISBN: 978-0521135900.

14. Report (2018). Probit EPA analysis Version 1.5. http://metricskey.net/probit/probit-program-version--1.5-software-download.

15. Wilkinson C.F. (1976). Insecticide Biochemistry and Physiology. Plenum Press, New York, 768. eBook ISBN:978-1-4899-2212-0.

16. Mastan S. and Shaffi S. (2010). Sub-lethal Effect of Pesticides on the Distribution of Glutaminases in the Brain of Labeo rohita (Ham.). *The Internet Journal of Toxicology*, 7(2), 27-32.

17. Dutta H.M., Nath A., Adhikari S., Roy P.K., Singh N.K. and Munshi J.S.D. (1994). Sublethal Malathion induced changes in the ovary of an air-breathing fish. *Heteropneustes fossilis* : a histological study, *Hydrobiologia*, 294(3), 215-218.

18. Mohan M.R. (2000). Malathion induced changes in the ovary of freshwater fish. *Glossogobiuss giuris* (Ham). *Pollution Res.*, 19(1), 73-75.

19. Bhandare R.Y., Pathan T.S., Shinde S.E., More P.R. and Sonawane D.L. (2011). Toxicity and behavioural changes in fresh water fish Puntius stigma exposed to pesticide (Rogor). *Am-Euras. J. Toxicol. Sci*, 3(3), 149-152.

20. Roger P.A. and Bhuiyan S.I. (1990). Rice field ecosystem management and its impact on disease vectors. *Int. J. Water Resour. D.*, 6(1), 2-18.

21. Mir F.A., Shah G.M., Jan U. and Mir J.I. (2012). Studies on influences of Sublethal Concentrations of Organophosphate Pesticide ; Dichlorvos on Gonadosomatic Index (GSI) of Female Common Carp , *Cyprinus carpio communis*. *Am.-Eurasian J. Toxicol.*, 4(2), 67-71.

22. Napti M.K. (2013). The effect of pesticides on fish fauna of Bhopal Lower Lake (MP). *Afr. J. Environ. Sci. Technol.*, 7(7), 725-727.

23. Goel P.K. (2006). Water pollution causes, effects and control. New Age International (P) Ltd , New Delhi, 97-115. ISBN : 812241009X, 9788122410099.

24. Sanders B.M. (1993). Stress proteins in aquatic organisms : an environmental perspective. *Crit. Rev. Toxicol.*, 23(1), 49-75.

25. Arunachalam S., Jeyalakshmi K. and Aboobucker S. (1980). Toxic and sublethal effects of carbaryl on a freshwater catfish, Mystus vittatus (Bloch). *Archives of environmental contamination and toxicology*, 9(3), 307-316.

26. Trivedy R.C. and Dubey P.S. (1978). Evaluation of toxicity of some industrial wastes to fish by bioassay. *Environ. Pollut.,* 17(1), 75-80.

27. PAN Pesticide Database- Chemical (2014). www.pesticideinfo.com.

28. Preston S., Coad N., Townend J., Killham K. and Paton G.I. (2000). Biosensing the acute toxicity of metal interactions: are they additive, synergistic or antagonistic?. *Environ. Toxicol. Chem.*, 19(3), 775-780.

29. Van Wijngaarden R.P.A., Crum S.J.H., Decraene K., Hattink J. and Van Kammen A. (1998). Toxicicity of derosal (active ingredient carbendazim) to aquatic invertebrates. *Chemosphere*, 37(4), 673-683.

30. WHO (1993). Environmental Health Criteria 149. Carbendazim World Health Organization, Geneva.

31. Ludwikowska A., Bojarski B., Socha M., Lutnicka H. and Trzeciak K.B. (2013). The effect of carbendazim on embryonic Prussian carp (Carassius gibelio) development and hatching. *Archives of Polish Fisheries*, 21(4), 367-371.