Journal of

Fisheries and Aquatic Science

ISSN 1816-4927

Academic Journals Inc.

www.academicjournals.com

Journal of Fisheries and Aquatic Science 8 (1): 233-237, 2013
ISSN 1816-4927 / DOI: 10.3923/jfas.2013.233.237

Toxicity of the Herbicide Propanil on *Oreochromis niloticus* Fingerlings

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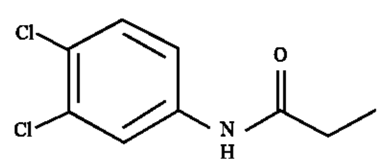
ABSTRACT

A static bioassay method to determine the acute toxicity of the herbicide propanil to *Oreochromis niloticus* was investigated under laboratory conditions for 96 h exposure period. Concentrations of propanil used include: 0.0096, 0.0103, 0.011 and 0.012 ml L^{-1}, respectively. The lethal concentration (LC_{50}) value of propanil on fingerlings of *Oreochromis niloticus* was 0.0097 ml L^{-1} for 96 h of exposure. The regression equation for probit kill from propanil was found to be Y = 29.84+12.33×log conc. (R^2 = 0.9951, Y = Probit kill). Fish showed various abnormal behaviors upon exposure to propanil. Immediate reaction was erratic swimming and tendency to jump out of the test bowl. Others include restlessness, un-coordinated movement, vertical swimming, air gulping, equilibrium loss, a period of quiescence and eventually death.

Key words: Propanil, acute toxicity, *Oreochromis niloticus*, Makurdi, water pollution, food security

INTRODUCTION

Propanil is a broad spectrum herbicide (Kellogg *et al*., 2000). According to Manson (1981), it is a selective broad spectrum herbicide used for the control of weeds in rice field. It decomposes within a short period after treatment which allows crops to be grown on the land in future seasons. According to Worthing (1987), it hydrolyses in extremely acidic or basic condition. But it is stable under normal temperature and pressure and may pose a slight fire hazard if exposed to heat or flame. Also, it poses a fire and explosion in the presence of strong oxidizers. Furthermore, that thermal decomposition of propanil will release toxic oxides of Nitrogen, carbon and corrosive fumes of chlorides. The molecular structure of propanil is as follows:



Molecular formula: $C_9H_9Cl_2NO$

Akobundu (1987) reported that herbicide run-off from Agricultural land is one method by which herbicides get into water. Seth *et al*. (1971) stated that herbicides can get into water through a number of routes; direct contact with water during chemical control of aquatic weeds, deliberate chemical dumping or disposal in water, indirect herbicide contact with water through run-off from agriculture land, deposition of herbicides that escaped into the air as drift.

Ovie (1985) and Ronald (1980) reported that residue of herbicide has been detected at phytotoxic concentration in ground water, lakes and streams as a result of run-off from treated fields. WSSA (1989) reported that propanil is toxic to aquatic invertebrates such as worms, snails, crayfish and to fish. The indiscriminate use of herbicides now to control weeds in crop fields especially the acute toxicity and behavioural effect of chlorpyrifos-ethyl pesticide to juveniles of *Clarias gariepinus* in rice fields, irrigated canals etc. has been on increase. Auta and Ogueji (2007) reported the acute fracture of vertebrate column, swollen abdomen, skin pigmentation and abnormal behaviors. The unpleasant development of the use of herbicides and pesticides to fish as a result of run-off from treated fields to ground water, lakes, streams, etc is yet to be fully assessed. This study was, therefore, aimed at investigating the effect of the use of Propanil on the mortality rate and behavioural pattern of *Oreochromis niloticus* fingerlings.

MATERIALS AND METHODS

Acclimatisation: Fingerlings of *Oreochromis niloticus:* mean weight 2.8±0.15 g and about 3.5±0.3 cm of length were collected from the University of Agriculture Fish Farm, Makurdi. The fish were acclimatised for 7 days in glass aquaria tanks measuring 60×30×30 cm containing de-chlorinated and aerated tap water at room temperature of 27.87±0.19°C. During the period of acclimation, fish were fed twice daily with fish meal at 3% b. wt. Water was changed every day to prevent the build-up of metabolic wastes and was aerated to increase oxygen supply. During the period of acclimation, fish were examined for pathogens and diseases. There was no mortality during the acclimation period.

Definitive test: Feeding was stopped 24 h prior to and during exposure period that lasted for 96 h. Acute toxicity test (96 h LC_{50}) was conducted in the laboratory following Hoque *et al.* (1993). Ten fingerlings of *O. niloticus* were randomly selected and transferred from the holding tanks into the duplicate test bowls (with 25 L of water) within 30 min of preparing the toxicant mixture. The Propanil concentration used were 0.0096, 0.0103, 0.011, 0.012 ml L^{-1}. There was a control in which ten fish were exposed to the University of Agriculture, Makurdi de-chlorinated tap water only. Aeration was provided by means of aerators prior to and during exposure period. Temperature condition was kept at room temperature and all aquaria were exposed to equal amount of natural light. The toxicant solution and test water were renewed after every 24 h during the bioassay. Mortality was observed and recorded at 1, 2 and 4 h and subsequently every 6 h up to 96 h. Fish were considered dead when gill movement ceased and no response was observed upon gentle prodding. Dead fish were recorded and removed immediately from test solutions to avoid fouling the media. The number of dead fish was counted in every bowl at observation time and recorded.

Water quality parameters: Water quality parameters were also monitored during the course of the experiment. Daily water quality parameter values were obtained using methods described by APHA (1985). Parameters recorded include: Dissolved oxygen (DO), alkalinity, free CO_2, temperature and pH.

Probit transformation of mortality was carried out to determine the 96 h LC_{50} of propanil on *O. niloticus*. Regression analysis was done to determine the 96 h LC_{50} of propanil on the test fish.

RESULTS AND DISCUSSION

Fish showed various abnormal behaviours upon exposure to propanil. Immediate reaction was erratic swimming and tendency to jump out of the test bowl. They were however constrained by the mosquito net screens placed on the test bowls. Other abnormal behaviour include: Restlessness, un-coordinated movement, vertical swimming, air gulping, equilibrium loss, a period of quiescence and eventually death. Percentage mortality and probit transformations for the various treatments are shown in Fig. 1. Mortality was highest with 0.012 ml L^{-1} concentration of propanil.

The LC_{50} value for 96 h was 0.0097 ml L^{-1} (Fig. 1). The computed regression equation for probit kill was found to be: Y = 29.84+12.33×log conc. (R^2 = 0.9951, Y = Probit kill).

The R^2 value of 0.9951 obtained in the regression equation shows that there is a strong correlation between probit kill and toxicant concentration. This implies that the higher the concentration of the herbicide, the higher the mortality.

Water quality parameters monitored during the test period shows that dissolved oxygen remained adequate surpassing the recommended minimum of 5.00 mg L^{-1}. There were significant differences in dissolved oxygen for the various concentrations with the control and lesser concentrations having higher dissolved oxygen values than treatments with high concentration of propanil. In terms of alkalinity, there was no significant difference for the various treatments. There was significant difference in concentration of free carbon IV oxide in the various treatments. The treatment with the highest concentration of propanil has the highest free CO_2 content. This can be explained by increased respiratory activity as a result of stress. Temperature was uniform through the four treatments and control. pH however varied among the treatments with lower values being recorded for the treatments while the control maintained a value of 7.217 which is close to the neutral value of 7.00. Table 1 gives a summary of the water quality parameter, in which the propanol had a depressed effect on the pH and dissolved oxygen on the treatment that has a higher concentration of propanol.

The LC_{50} values derived from the toxicity test showed that *Oreochromis niloticus* is sensitive to the herbicide. Sancho *et al.* (2009) reported an LC_{50} of 31.55 mg L^{-1} for European eel *Anguilla anguilla* exposed to propanil. Moraes *et al.* (2009) reported that glycogen levels in the liver of *Leporinus obtusidens* were increased after exposure to both clomazone and propanil. The

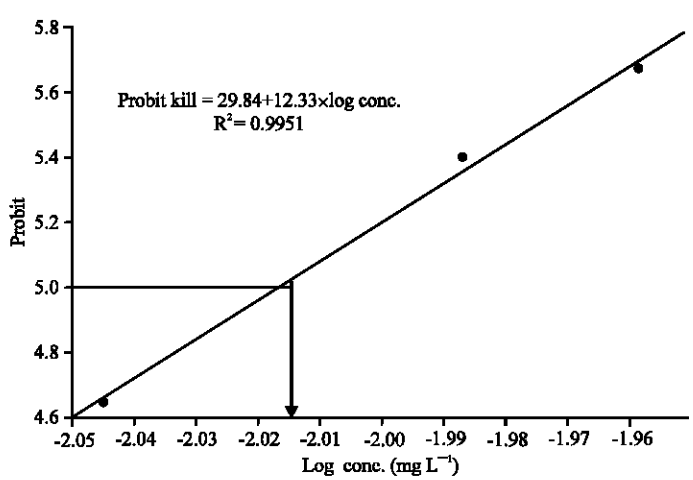


Fig. 1: Regression curve of probit kill and log concentration of propanil on *O. niloticus*

Table 1: Water quality parameters of the various holding tanks by treatment used to determine the LC_{50} of propanil on *O. niloticus*

Concentration (ml L^{-1})	DO (mg L^{-1})	Alkalinity (ppm)	Free CO_2 (mg L^{-1})	Temperature (°C)	pH
0.009	7.30 ± 0.200^a	33.58 ± 0.51^a	3.750 ± 0.080^b	27.90 ± 0.30^a	6.600 ± 0.076^b
0.0103	7.17 ± 0.017^a	32.47 ± 0.73^a	3.900 ± 0.058^a	27.72 ± 0.36^a	6.733 ± 0.044^b
0.011	6.76 ± 0.133^b	32.33 ± 0.60^a	3.700 ± 0.050^b	27.47 ± 0.74^a	6.650 ± 0.161^b
0.012	6.68 ± 0.159^b	33.18 ± 0.46^a	4.033 ± 0.033^a	27.77 ± 0.38^a	6.693 ± 0.070^b
Control	7.40 ± 0.058^a	31.37 ± 0.68^a	3.767 ± 0.033^b	27.87 ± 0.19^a	7.217 ± 0.044^a

Means±SE in the same column followed by the same superscript are not significantly different at $p>0.05$

muscle tissue showed a significant decrease of glycogen and lactate after clomazone and propanil exposure. Glucose levels were significantly decreased in the muscle when the fish were exposed to clomazone, but exposure to propanil did not alter this parameter.

The behavioural responses of *Oreochromis niloticus* in the present study is similar to the findings of Annune *et al.* (1994), Annune and Ejike (1999), Anadu and Ajana (1988), Avoaja and Oti (1997), Lovely (1998) and Oti (2000) observed that at higher concentration of herbicide (toxicant) exposed at 96 h to fish showed several fish abnormal behaviour of restlessness, loss of equilibrium, erratic swimming, respiratory distress, air gulping and death. Ronald (1980) and Stefferud (1990) reported the hazard effect to fish on use of herbicide for weeds control in an aquatic environment. Shultz (1971) reported several cell damage especially of the pancreas after contact with herbicides. Annune and Ejike (1999) reported that gill tissues are most sensitive to herbicides since gills are the primary site for osmoregulation and respiration. Kolo *et al.* (2008) reported that glyphosate at low concentration, 96 h LC_{50} values of 8.0, 8.1 and 8.2 mg L^{-1} was toxic to *Tilapia zilli*. Also, the test fish exhibited abnormal behaviours such as erratic swimming and loss of equilibrium. Other reports of abnormal behaviour as a result of exposure to propanil includes that of Sancho *et al.* (2009) with reports of torpor, reduction in swimming performance, lethargy and presence of small dots all over the skin/scales of *Anguilla anguilla* exposed to propanil after two hours and that these increased in number with increase in exposure time. Moraes *et al.* (2009) reported that *Leporinus obtusidens* exposed to propanil and clomazone resulted to a significant decrease in acetylcholinesterase as well as catalase activity in all tissues.

CONCLUSION

Propanil was found to be toxic to *Oreochromis niloticus* fingerlings and the effect increased with increase in concentrations. There is need to set quality standard by appropriate authorities on the use of propanil in aquatic ecosystem. This will reduce the deleterious effects on the environment, other living aquatic organisms and man.

REFERENCES

APHA, 1985. Standard Methods for Examinations of Water. 15th Edn., APHA, Washington DC., USA., pages: 1076.

Akobundu, I.O., 1987. Weed Science in the Tropics: Principles and Practices. John Wiley and Sons, New York.

Anadu, D.I. and A.O. Ajana, 1988. Toxicity of a herbicide (mixture of Bintazone and Propanil) on *Tilapia zilli* in Nigeria. J. Agric. Technol., 1: 59-67.

Annune, P.A. and S.U. Ejike, 1999. Acute toxicity and gill morphology of *Oreochromis niloticus* (Trewavas) expressed to rogor. J. Aquatic Sci., 14: 1-4.

Annune, P.A., S.O.N. Hbele and A.A. Oladimeji, 1994. Acute toxicity of cadmium to juveniles of *Clarias gariepinus* (Tuegls) and *Oreochromis niloticus* (Trewavas). J. Environ. Sci. Health, 29: 1357-1365.

Auta, J. and E.O. Ogueji, 2007. Acute Toxicity and behavioural effects of Chlorpyrifos-ethyl pesticide to juveniles of *Clarias gariepinus* (Teugels). Proceedings of the 22nd Annual Conference of Fisheries Society of Nigeria (FISON), November 12-16, 2007, Birnin Kebbi, Nigeria, Pp: 264-272.

Avoaja, D.A. and E.E. Oti, 1997. Effects of sublethal concentrations of some pesticides on the growth and survival of the fingerlings of African freshwater catfish-heteroclarias (Hybrid). Nig. J. Biotechnol., 8: 40-47.

Hoque, M.M, M.J.A. Mirja and M.S. Miah, 1993. Toxicity of romil to fingerlings of *Clarias gariepinus*. Bangladesh J. Transnat. Develop., 1: 19-26.

Kellogg, R.L., R. Nehring, A. Grube, D.W. Goss and S. Plotkin, 2000. Environmental indicators of pesticide leaching and run-off from farm fields. Agric. Product., 2: 213-256.

Kolo, R.J., S.L. Lamai and R.O. Ojutiku, 2008. Sub-acute toxicity of gramoxone to *Clarias gariepinus* (Burchell 1820). Proceedings of the 4th Annual Conference of Fisheries Socieity of Nigeria (FISON), October 27-30, 2008, Kaduna State,.

Lovely, F., 1998. Toxicity of three commonly used organophosphorus herbicide to their sharpute (*Borbodes gonionotus*) and African catfish (*Clarias gariepinus*) fry. M.Sc. Thesis, Department of Fisheries and Genetics. Bangladesh Agricultural University, Mymensingh, Bangladesh.

Manson, C.F., 1981. Biological of Fresh Water Pollutant. Longman Publisher, London, pp: 105-130.

Moraes, S.B., V.L. Loro, A. Pretto, M.B. da Fonseca and C. Menezes *et al*., 2009. Toxicological and metabolic parameters of the teleost fish (*Leporinus obtusidens*) in response to commercial herbicides containing clomazone and propanil. Pesticide Biochem. Physiol., 95: 57-62.

Oti, E.E., 2000. Acute toxicity of water extracts of bark of the *Thevetia peruviana* to the African freshwater catfish heteroclarias hybrid fingerling. J. Fish. Technol., 2: 124-130.

Ovie, S.I., 1985. Zooplankton study of round valley resorvoir. M.Sc. Thesis, University of West Florida, Pensacola, Florida, USA.

Ronald, E., 1980. Acute Toxicity of Herbicides to Freshwater Fish and Midge Larvae. Springer-Verlag, New York, pp: 107-125.

Sancho, E., C. Fernandez-Vega, E. Andreu and M.D. Ferrando, 2009. Effects of propanil on the European eel *Anguilla anguilla* and post-exposure recovery using selected biomarkers as effect criteria. Ecotoxicol. Environ. Saf., 72: 704-713.

Seth, A.K., C.H. Khaw and J.M. Fua, 1971. Minimal and zero tillage techniques and post planting weed control in rice. Proceedings of the 3rd Asian Pacific Weed Science Society Conference, June 7?12, 1971, Kuala Lumpur, Malaysia, pp: 188-200.

Shultz, D., 1971. Fish Pathology. T.F.H. Publications Inc., New Jersey, pages: 512.

Stefferud, A., 1990. The Yeardbook of Agricultural Soils. Governmet Printer, Washington DC., USA., pages: 784.

WSSA, 1989. Herbicide Handbook of the Weed Science Society of America. 6th Edn., WSSA Herbicide Handbook Committee WSSA, Champaign, IL., Pages: 301.

Worthing, C.R., 1987. The Pesticide Manual: A World Compendium. 8th Edn., The British Crop Protection Council, Croydon, England.