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Effect of Sublethal concentration of sniper 1000EC on weight and length growth of *Oreochromis niloticus* obtained from Asa dam under laboratory conditions

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Abstract

The study investigated the effect of sublethal concentration of sniper 1000EC on the weight and length growth of *Oreochromis niloticus* obtained from Asa dam under laboratory conditions. Indiscriminate use of Sniper 1000EC by fishermen has become a serious problem in Northern region of Nigeria. Juveniles of *Oreochromis niloticus* (mean body weight 7.05± 1.02; mean standard length.9.60±0.38cm) were subjected to 5 sublethal treatment levels: 0.00mg/L is the control, 0.12, 0.15, 0.19 and 0.25mg/L. There was no significant difference between water quality parameters of the exposed and control groups. A 56 day exposure to sublethal concentrations of the toxicant led to a significant decrease ($p<0.05$) in specific and relative growth rate in the exposed fish species in comparison with their controls. Change in weight and length decreases with increasing sublethal concentrations of sniper 1000EC. It is concluded that depressive growth rate in the exposed fish species were consequences of exposure to the toxicant (sniper 1000EC).It is recommended that the use of Sniper 1000EC by local fishermen be banned to save the aquatic environment from destruction.

***Keywords**:* Sniper 1000EC, *Oreochromis niloticus*, chronic toxicity and growth rates.

Introduction

Weight and length data provide a very useful tool for estimating growth rates, length, and age structuresand for the improvement of the knowledge regardingfish population dynamics (Froese, 2006). Weight-length relationship is very useful for fisheries research because they allow the conversion of growth-in-length equation to growth-in-weight for use in stock assessment models (Moutopoulos and Stergiou, 2000). Length-weight relationship allow for estimation of biomass from length observations as well as comparisons of life histories of certain species (Goncalves *et al*., 1996; Froese and Pauly, 1998). They are important component of FishBase (Froese and Pauly, 1998). Pauly (1993) stated that length-weight relationship provides valuable information on the habitat where the fish lives while Kulbicki *et al*.,(2005) highlighted the significance of length-weight relationship in modeling of aquatic system. Length-weight is useful for the conversion of growth-in-length to growth-in-weigth for use in stock assessment models and to estimate stock biomass from limited sample sizes (Ecoutin *et al*., 2005). Length and weight measurements can give information on the stock composition, life span, mortality, growth and production (Bolger and Connoly, 1989; Erkoyuncu, 1995; King, 1996; Moutopoulos and Stergiou, 2000).

Tilapia fishes are important source of animal protein to humans. They are obtained through capture fisheries activities and also farmed in ponds. They dominate major inland water bodies including rivers, lakes and reservoirs in major fish landings (Trewavas, 1982). Tilapia is one of the fisheries resources that suffers from environmental effects and needs to be protected because world production of tilapia exceeds two million tons per year far exceeding the harvest of Atlantic salmon and secondary only to carp as a culture food fish (FAO, 2005). Tilapia has become the shining star of aquaculture across the globe (Waleed, 2012). Fagbenro (2002) stated that tilapia species are of major economic importance in tropical and sub-tropical countries throughout the world, particularly in Africa where farms stock mixed-sex tilapia in production ponds. Arrignton (1998) describes *Oreochromis niloticus* as the best species for culture-among the tilapia family-with squat shape. Trewavas (1982) recognized *Oreochromis niloticus* as macrophages and herbivorous used in irrigation channels and dams to control weed. Fagbenro (2002) stated that tilapia species are of major economic importance in tropical and sub-tropical countries throughout the world, particularly in Africa where farms stock mixed-sex tilapia in production ponds. There are different species of tilapia fish in Asa dam but *Oreochromis niloticus* is more abundant. *Oreochromis niloticus* can survive in bad environmental conditions because their resistance to disease is physically powerful, and their respiratory demands are slight so that they can accept low oxygen and high ammonia levels (Zhou *et al*,. 1998). They are disease resistant, highly prolific; feed on wild variety of foods, tolerant of poor water quality with low dissolved oxygen level (Fagbenro, 2002).

Widespread application of various pesticides has aggravated the problem of pollution to aquatic environment. Due to these synthetic chemicals, environment has failed to keep its healthy characteristics. The insecticides of proven economic potentialities could not do well in the ecosystem when viewed on extra fronts since these revenue poisons, in a residual form or as a whole, get into the aquatic ecosystem. They cause a series of problems to aquatic organisms (Mastan and Ramayya, 2010).

Sniper 1000 EC is the common pesticide among the local farmers cultivating crops around Asa dam, Ilorin. In line with the saying, “When Sniper and Mussel struggles inside water, it is the local fishermen that smile home” (Abubakar, 2013). Indiscriminate use of Sniper 1000EC by fishermen around Asa dam has become a serious problem to be studied. Sniper 1000EC (2, 3-dichlorovinyl dimethyl phosphate), a brand of dichlorvos, is contact acting and fumigant insecticide (Abubakar, 2013). Like all organophosphates, it kills insects and other target organisms because of its toxicity to the nervous system. This is achieved by inhibition of enzyme acetylcholinesterase (AchE) that breaks down acetycholine at the receptor site for partial uptake into the nerve terminal. Without functioning AchE, accumulation of acetylcholine results in depolarizing block of muscle membrane, producing rapid twitching of involuntary muscles, convulsions, paralysis and early death. Indiscriminate use of Sniper 1000EC is common among local fishermen from Northern parts of Niger state.

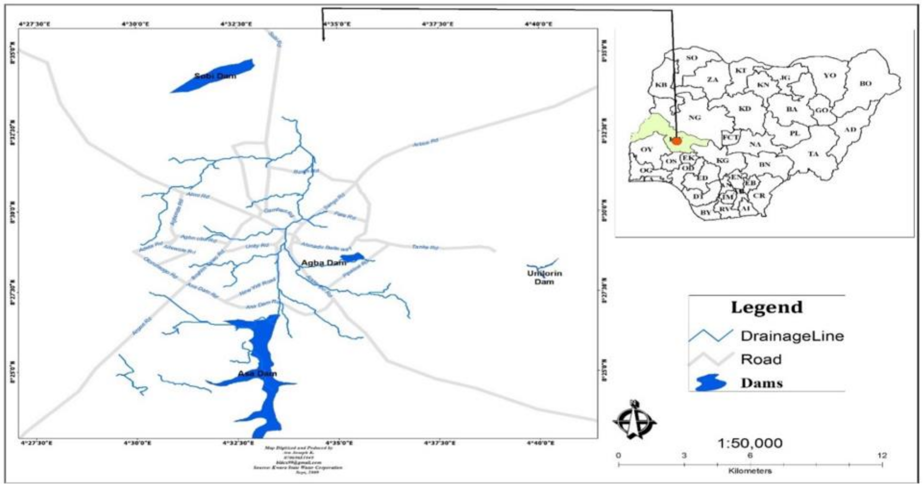
There is paucity of information on toxicity of sublethal concentrations of sniper 1000EC on weight and length growth of tilapia fish despite its indiscriminate use by the fish farmers.

Accordingly, this investigation is aimed at evaluating the effect of sublethal concentrations of sniper 1000EC on weight and length growth rates of *Oreochromis niloticus* under laboratory conditions.

Materials and methods

The Study Area

The study was conducted in Asa dam which is located in Ilorin, the capital of Kwara State, Nigeria.



Source: Clement *et al*., 2015

Figure 1: Map of Ilorin showing the location of Asa dam. Inset: map of Nigeria showing the states

Asa dam is located on River Asa (8_ 4400 N; 4_ 5600 E) at approximately 5 km from the city centre. The dam has an overall length of 597 m and storage capacity of 43 million m^3 with lake extension of 18 km. The length and breadth of the spillway are about 65 m and 14 m respectively with discharge capacity of 79,000 m^3 (Araoye, 2009; Ayanshola, 2013). Asa River is the major river in Ilorin city. Ilorin is mainly drained by Asa River which flows in a South-North direction (Ajadi *et al*., 2016). The river has a total surface area of about 303 hectares (Olayemi, 1994; Eleta *et al*., 2005). Other rivers in Ilorin that drains into Asa river are river

Agba, river Alalubosa, river Okun, river Osere, river Aluko, river Yalu, river Odota and river Loma.

Sample collection, transportation and test chemical

Juveniles of *Oreochromis niloticus* (mean body weight 7.05±1.02kg; mean standard length.9.60±0.38cm) were obtained from Asa dam using drag nets with the help of the local fishermen. The samples were transported to the laboratory in plastic container of 100L capacity filled with water to two-third volume between 0700 hours and 0900 hours. They were held in large water baths of 160L capacity and acclimated for 14days to laboratory conditions. The top of water bath was covered with netted material to prevent jumping out of the fish. A slit was made at middle of the net to allow for feeding fish and cleaning of the bath. Feeding commenced two days after the arrival and stopped twenty-four hours before the commencement of the experiment. During acclimation, fish were fed twice daily (0800 and 1600 hours) with formulated feed (35% crude protein) at 3% body weight. The fishes were accepted as well as adapted to laboratory conditions when less than 5% death was recorded for the 14 days. The water in the bath was changed daily and uneaten food and faecal matters were siphoned out. Dead fish were also removed to minimize contamination of water.

Test chemical (2, 3-dichlorovinyl dimethyl phosphate), a brand of Dichlorvos with the trade name Sniper 1000EC was obtained from Ilorin central market and was used for the study. The test concentrations were prepared after range finding tests had been conducted.

Experimental Design

The experimental design was a complete randomized design. A total of one hundred and fifty (150) juvenile of *Oreochromis niloticus* were randomly distributed into the tanks at a stocking rate of 10 fish per tank. The fifteen (15) tanks were assigned to 5 treatments (control inclusive). In order to determine the LC_{50}, the *O.niloticus* were exposed to four different concentrations of sniper 1000EC for 96hr. LC_{50} value obtained using EPA Probit Analysis programme version 1.5 was 3.81mg/L. Using the method of Abubakar and Abdulsalami (2013), One fifteen (1/15), one twenty (1/20), one twenty fifth (1/25) and one thirty (1/30) of 3.81mg/L were used to produced the sublethal concentrations used in the study.

1/15 x 0.00mg/L=0.00mg/L

1/15 x 3.81mg/L = 0.25mg/L

I/20 x 3.18mg/L = 0.19mg/l

1/25 x 3.18mg/L = 0.15mg/L

1/30 x 3.18mg/L = 0.12mg/L

The Aqua feed used for feeding the fish composed of 35% of ground nut cake, 30% of fish meal 20% of rice bran, 5% of bone meal, 5% of vegetable oil and 5% of vitamin and mineral premix respectively (Table 1).

Table 1:Ingredient of the Aqua feed used:

INGREDIENTS	% COMPOSITION
Groundnut cake	35
Fish meal	30
Rice bran	20
Bone meal	5
Vegetable oil	5
Vitamin and mineral pre-mix	5
Aqua feeds total	100

The fish were fed 3 times daily .The test solutions were renewed forthrightly. The average weight and length of the fish were measured bi-weekly using a 3- digit sensitive weighing balance Meter pm 2500 Delta range ®. For clarity purpose, a transparent ruler was used for the measurement of length. The experiment lasted for 56 days (8weeks).Growth was based on relative and specific growth rates which were calculated using standard formulae:

$$GR = \frac{W_t - W_o}{W_0} \times 100$$ ----- Haghighi, 2009:

$$RG_R = \frac{W_t - W}{t_2 - t_1}$$ ------ Goda *et* al, 2007:

$$SGR = \ln \frac{Wt - W_0}{W_0}$$ ----- Akintola *et al*., 2010:

Where:

W_t = Final body weight at time t (weeks);

W_o = Initial body weight at time 0(weeks);

GR = Growth rate;

RG_R = Relative growth rate;

SG_R = Specific growth rate;

t_1 = Initial time;

t_2 = Final time:

Water quality parameters

Dechlorinated municipal tap water was used. It was allowed to stand for 72 hours during which it was aerated. The water quality parameters determined were temperature, dissolved oxygen, pH, water hardness and total alkalinity which could adversely affect survival and growth of fish in tanks.Temperature and dissolved oxygen were monitored on daily basis (09:00 and 14:00 hours) using a thermometer and oxygen meter(Cole Parma model 5946; Sigma Chemical, Berlin, Germany). The values of pH were measured daily using an Orion digital pH meter (Model 210; Sigma Chemical, Lisbon, Portugal). Water hardness was monitored daily using a German hardness scale while total alkalinity were monitored on weekly basis using standard method of APHA (1987). These were done to ensure proper recordings and calculations of the parameters.

Statistical Analysis

All the data generated were managed with Microsoft office Excel 2003; they were analyzed with one-way analysis of variance (ANOVA) using Statistical Product for Service Solution (SPSS), version 16.0 for window. Statistical significance of difference among means was compared for significant differences using Duncan's New Multiple Range tests at 95% probability (Snedecor and Cochram, 1980).

Results

Effects of sublethal concentrations on water quality parameters

The water quality variables at various sub lethal treatments for the exposed and control groups did not differ significantly ($p<0.05$).The mean values recorded for various sublethal concentrations compared with those of the controls are presented in Table 2.

Table 2: Physio -chemical parameters of chronic test solutions for *Oreochromis niloticus* (mean±SD)

Concentration	pH	Temperature (OC)	Dissolved oxygen (mg/L)	Hardness (mg/L)	Alkalinity (mg/L)
0.00	6.64±1.70	28.6±1.52	7.50±0.30	39.1±2.81	33.7±2.13
0.12	6.67±0.51	28.8±2.09	7.63±0.28	40.2±3.26	33.3±1.54
0.15	6.56±0.42	28.6±1.51	7.65±0.29	40.4±2.22	33.0±2.37
0.19	6.59±0.49	28.5±2.04	7.68±0.27	40.2±3.42	34.1±2.14
0.25	6.62±0.45	28.6±1.61	7.67±0.22	39.4±3.86	34.3±1.56

values of parameters along the same column are not significantly different at ($p<0.05$)

Effect on growth rates

Differences in weight and length among the exposed fish species at various

sublethal concentrations were significant ($p<0.05$). Weight ranged from 16.4g in the control tank to 13.6g in the highest concentration tank

(0.25mg/L). Change in length ranged from 9.5cm in the control tank to 7.6cm in the highest concentration tank (0.25mg/L). Differences were also observed in the growth rates, specific growth rates and relative growth rates of the two fish species exposed to the various concentrations of sniper 1000EC. The toxicant exhibited depressive effect on the exposed groups with increase in concentration levels in the exposed fish species. These are shown in Tables 3 to 6.The change in weight of *Oreochromis niloticus* at different concentration levels of sniper 1000EC are presented on Table 3. The results show that the bi-weekly change in weight declined with increase in concentrations of sniper 1000EC.

Table 3: Weekly change in weight (g) at different concentration level of sniper 1000EC in *Oreochromis niloticus*

Concentration	Mean change in weight			
	WK2	WK4	WK6	WK8
0.00mg/L	16.4^a	16.6^a	16.6^a	16.7^a
0.12mg/L	16.2^a	15.9^a	15.8^a	15.6^a
0.15mg/L	15.8^a	15.3^a	15.2^a	14.9^a
0.19mg/L	14.7^a	14.5^a	14.3^a	14.2^a
0.25mg/L	14.0^a	13.8^a	13.7^a	13.6^a

Mean with the same superscript along column are not significantly different at (p<0.05)

NB

WK denotes week

WK2 denotes Second week

WK4 denotes Fourth week

WK6 denotes Sixth week

WK8 denotes Eight week

Data for change in length of *Oreochromis niloticus* at different concentration levels of sniper 1000EC are shown in Table 4. The Table revealed that the mean change in length decreased insignificantly (p>0.05) with increase in concentrations of sniper 1000EC.

Table 4. Bi-weekly change in length (cm) at different concentration levels of sniper 1000EC in Oreochromis niloticus.

Concentration	Mean change in length (cm)			
	WK2	WK4	WK6	WK8
0.00mg/L	9.5[a]	9.5[a]	9.6[a]	9.7[a]
0.12mg/L	9.2[a]	9.1[a]	9.0[a]	9.0[a]
0.15mg/L	9.0[a]	8.9[a]	8.7[a]	8.6[a]
0.19mg/L	8.5[a]	8.4[a]	8.2[a]	8.1[a]
0.25mg/L	8.0[a]	7.8[b]	7.7[a]	7.6[a]

Mean with the same superscript along column are not significantly different at ($p<0.05$)

NB

WK denotes Week

WK2 denotes Second week

WK4 denotes Fourth week

WK6 denotes Sixth week

WK8 denotes Eight week

Table 5 shows the growth rate, specific growth rate and relative growth rate in weight at various concentration levels of sniper 1000EC in *Oreochromis niloticus*. The Table shows that growth rate, specific growth rate and relative growth rate declined with increase in concentration of sniper 1000EC.

Table 5. Mean Initial weight, Mean final weight, Specific growth rate and Relative growth rate in *Oreochromis niloticus*

Concentration	Mean Initial weight (g)	Mean Final weight (g)	Growth rate (g)	Specific growth rate(g)	Relative growth rate (g)
0.00mg/L	13.0[a]	16.7[a]	28.5[a]	1.2[a]	0.29[a]
0.12mg/L	13.4[a]	16.2[a]	21.0[b]	0.9[a]	0.21[a]
0.15mg/L	12.9[a]	15.3[b]	18.6[c]	0.8[a]	0.19[a]
0.19mg/L	13.2[a]	15.0[b]	13.6[d]	0.6[a]	0.14[a]
0.25mg/L	13.5[a]	15.3[b]	13.3[d]	0.6[a]	0.13[a]

Mean with the same superscript along column are not significantly different at ($p>0.05$)

The growth rate, specific growth rate and relative growth rate in length of *O. niloticus* at different concentration levels of sniper 1000EC are shown in Table 6. The Table shows a similar trend as in weight. Growth rate, specific growth rate and relative growth rates also decreased with increase in concentrations of sniper 1000EC.

Table 6. Mean initial length, Mean final length, Specific growth rate and Relative growth rate in *Oreochromis niloticus*;

Concentration	Mean Initial length (cm)	Mean Final lenghth (cm)	Growth rate (cm)	Specific growth rate(cm)	Relative growth rate (cm)
0.00mg/L	7.8^{a}	9.7^{a}	24.4^{a}	0.6^{a}	0.24^{a}
0.12mg/L	7.4^{a}	8.9^{b}	20.3^{b}	0.5^{a}	0.20^{a}
0.15mg/L	7.2^{a}	8.4^{b}	16.7^{c}	0.4^{a}	0.17^{a}
0.19mg/L	7.1^{a}	8.2^{b}	15.5^{d}	0.4^{a}	0.16^{a}
0.25mg/L	7.7^{a}	8.6^{b}	11.7^{e}	0.3^{a}	0.12^{a}

Mean with the same superscript along column are not significantly different at ($p>0.05$)

Discussion

The effect of sublethal concentrations of sniper 1000EC has depressive effect on the growth rate of *Oreochromis niloticus*. The fish exhibited a progressive decline in growth at various concentration levels. This is in agreement with the work of Abubakar and Abdulsalami (2013) who worked on toxicological effects of sublethal concentrations of sniper 1000EC on growth of *Clarias gariepinus* under laboratory conditions. The results of water quality parameters of the media were within the optimal range recorded by Omoniyi *et. al.*, (2002) as requirements for fish *culture* which implied that the parameters did not seem to influence the toxicity of the pesticide to the test fish .Exposure to toxicant without causing death to organisms can still cause harm (Stephan, 1982) and survival of estuarine and marine organisms in relatively low concentrations of toxicant on the first day, does not necessarily indicate that they are resistant to the toxicant pollution (Mironov, (1972). Decreased growth was reported on *Mesidotea etemon* by Percy (1978). A similar reduction in growth was also observed by Abubakar and Abdulsalami (2013) when they worked on toxicological effects of sublethal concentrations of sniper 1000EC on growth of *Clarias gariepinus*. Reduction in growth was also observed by Toussain, *et al*., (2001) and Onusiriuka (2002) when they exposed

Japanese Medaka fish and *Clarias gariepinus* to sub-lethal concentrations of chloroform and formalin respectively, better growths were reported in control groups of certain fish than those exposed to toxicants as observed in this study. This might be due to the fact that they were able to utilize the feeds or that the feeds were palatable. This observation was in agreement with the reports of Omoregie and Okpanach (1995) in Tilapia zilli: Omoregie *et al.*, (1998) in *Oreochromis niloticus*; Omoregie and Onuogu (2000) in *Aphyosemion gardneri*. Literature reports often attributed the decline in growth rates to the impairment of feeding by fish in the toxicant polluted area as observed in this study. Several workers have reported similar findings (Shanmugavel, *et a*l., 1988; Auta 2001 and Toussain, *et al.,* 2001). This might also be due to the presence of a dominant aggressive fish that caused an increased activity for others and consequently a reduction in their growth rates as well as an increase in their sensitivity of the pollutant. The dose- dependent effects of sniper 1000EC on the growth rates of the fish species suggested that high concentration of the toxicant inhibited the feeding rate of the fish species or make the feed unpalatable for them. Pal and Konar (1987) similarly reported that growth rate of *Oreochromis mossambicus* was considerably reduced by sublethal concentrations of organophosphorus insecticides. Other pollutants have also been reported to decrease fish growth and survival as recorded in Petroleum effluent by Omoregie *et al.,*(1997), Paraquat by Babatunde (1997) and Tannery by Adakole (2005). Decrease in weight and standard length of the treated fish species may be attributed to the stress they experience while adjusting to attain a tolerance level with the toxicant (Abubakar and Abdulsalami, 2013).

Conclusion

In conclusion, abnormalities in growth rates of the exposed fish species were associated with the effects of sublethal concentrations of sniper 1000EC.By this context, the toxicant has to be taken into more consideration as an environmental contaminant. The use of sniper 1000EC by fishermen should be banned to save the aquatic ecosystem and more studies recommended for further evaluation of this toxicant.

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