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Sub-Lethal Effect of 2,4-Dichlorophenoxy-Acetic Acid on Growth and Food Utilization of the African Cat Fish *Clarias gariepinus* (Teugals)

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Abstract: The effect of sub-lethal concentrations 2.89, 3.62 and 4.83 mg L^{-1} of 2,4-Dichlorophenoxy-acetic acid (Cereal herbicide) on growth, nutrient and body composition of *Clarias gariepinus* were studied in the laboratory. The growth rates were sgnificantly reduced in fish exposed to the toxicant compared with the control groups. The nutrient utilization showed that, SGR, FCR, FCE, FE, PER and NM were significantly higher ($p<0.05$) in the control fish than the exposed groups. The investigation revealed that, low concentration of 2,4-D causes various physiological effects to the fish. The usage of this herbicide near water bodies where fish abound should be monitored and controlled.

Key words: 2,4-Dichlorophenoxy-acetic acid, effect, growth, *Clarias gariepinus*

INTRODUCTION

Pollution and contamination of aquatic environment is increasing in scope and magnitude. This could be attributed to increasing agricultural practices, development of various types of industries, increase in human population especially in urban centers and the inadequate considerations to environmental impact analysis of the various developmental projects (Akpata, 1986). Pollution brings undesirable changes in the environment, which could affect the biotic composition of the ecosystem. In recent years, serious concern has been voiced about the rapid deteriorating state of freshwater bodies with respect to pesticides. It is recognized that in fresh water systems, pesticides have high pollution potential that could be measured through the use of fish (Tariq *et al*., 1996). Most of the pollutants are either emissions to the atmosphere or as discharges to water bodies, or directly through the introduction of the chemical to attack particular organisms such as in pest control programs (Holden, 1977).

In recent years, the use of DDT and the related compounds have been phased out in North America and through out much of the world including Nigeria and replaced by methoxychlor but because of its vector control use, DDT is still in use in several parts of Africa (Pepple, 1973). Pesticides have bioaccumulation tendency, whereby they do not remain in one place, but their residue can be carried to distant places and from one organism to the other via the food chain.

In Nigeria, awareness on the dangers of pesticides is very poor. Toxicity of pesticides on rats and man is much in literatures, but little information is available on their effects on fish and other aquatic organisms (Pepple, 1973). With the exception of the publication on guidelines and standards for environmental pollution control in Nigeria, there is no any governmental regulations or control measure on the use of pesticides and other potential environmental toxicicants in Nigeria.

Therefore, there is the need for studies to be carried out to determine the effect of the various chemicals on aquatic life, especially fish. Information emanating from such research is required to provide baseline data on pesticides produced in the developed worlds for developing and underdeveloped worlds (EPA, 2000).

The choice of herbicide 2, 4-Dichlorophenoxyacetic acid for this study is because it is a widely used in the control of wide variety of broad leaf weeds in this country both upland and in fadama for the cultivation of rice.

MATERIALS AND METHODS

Experimental fish: Fingerlings of *Clarias garpinus* with average standard length of 15.75±0.65 cm and body weight of 24.62±1.07 cm used for the study were obtained locally from Maigana Fish Farm near Zaria. The experimental fish were conveyed to the Fisheries Laboratory, Department of Biological Sciences, Ahmadu Bello University Zaria in plastic jericans. The fish were held in the laboratory in one large water bath of 160 L

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capacity. During acclimatization for 2 weeks, 3 quarters of the test water was changed daily by siphoning out the spent water. The tank was checked daily for fish mortality. During this period, the fish were fed with pelleted feeds containing 35% crude protein.

Sublethal test: Four aquaria tanks with dimension 30×30×45 were set up as described earlier. The nominal concentrations of 2, 4-D used were 2.89, 3.62 and 4.83 mg L^{-1}, one of the four tanks served as control. The bioassay was conducted in triplicate. A total of 120 juveniles of *Clarias gariepinus* were sorted randomly into the glass tanks at 10 fish per tank. Experimental tanks were cleaned every 2 days before first feeding by siphoning dirt, unconsumed feed and faeces with flexible hose. The water level in the tanks were then maintained by adding fresh water from the reservoir and appropriate volumes of the toxicant added into each tanks, except the control tanks (Auta, 2001).

Growth studies: Growth was monitored as described in guideline 210 (OECD, 1992). Feeding of fish was carried out thrice daily at a feeding rate of 5% body weight with pelleted diet containing 35% crude protein. Daily ration was split to three and fed thrice (8:00 am, 1:00 pm and 6:00 pm) per day. Quantity of daily ration was adjusted weekly based on fish weight increment.

The weight gain of fish in each tank was obtained weekly, by cropping the fish in each tank and weighed in a plastic container on an electric top loading metler balance 800 gm maximum capacity. The average weight of fish in each tank was then determined by dividing the total weight by the number of fish.

Statistical analysis: Analysis of Variance (ANOVA) and Duncan multiple range tests were employed to test for the relationship between the various parameters. Test of significance were at 95% probability. Regression coefficient between the probit kill and log concentration of the toxicant was determined after the acute toxicity bioassay. Differences between treatments (CRD). Correlation coefficient (r) was used to determine.

RESULTS

Growth studies: Weight gain, Specific Growth Rate (SGR), Gross Feed Conversion Efficiency (GFCE),Feed Efficiency (FE), Protein Efficiency Ratio (PER) and Nitrogen Metabolism (NM) were significantly higher ($p<0.05$) in the control fish compared to the groups exposed to the toxicant (Table 1 and 2), while Feed Conversion Ratio increased with increasing concentration of the toxicant.

Table 1: Growth performance of *C. gariepinus* exposed to sublethal concentration of 2, 4-D

	Concentration (mg L^{-1})			
Parameter	0.00	2.89	3.62	4.83
No. of fish	10	10	10	10
Mortality (%)	0	0	0.46	0.74
Av. initial weight (g)	24.82	18.56	21.23	17.62
Av. final weight (g)	38.26	28.32	29.21	20.56
Weight gain (g) %	54.14	52.58	37.58	16.68
Weight gain (g)	$13.44^{a}\pm0.25$	$9.76^{b}\pm1.03$	$7.98^{c}\pm1.24$	$2.94^{d}\pm0.06$
SGR	$1.13^{a}\pm0.03$	$1.08^{a}\pm0.02$	$1.07^{a}\pm0.01$	$0.94^{a}\pm0.01$

Means with the same superscript in rows are not significantly different ($p>0.05$)

Table 2: Nutrient composition of *C. gariepinus* exposed to sublethal concentration of 2, 4-D

	Concentration (mg L^{-1})			
Parameters	0.00	2.89	3.62	4.83
FCR	$2.32^{c}\pm0.03$	$6.42^{bc}\pm1.66$	$7.46^{b}\pm1.76$	$10.75^{a}\pm1.82$
GFCE	$99.24^{a}\pm8.26$	$36.52^{b}\pm4.62$	$36.23^{b}\pm4.36$	$16.31^{b}\pm2.03$
FE	$0.86^{a}\pm0.02$	$0.72^{a}\pm0.03$	$0.64^{a}\pm0.02$	$0.32^{a}\pm0.01$
PER	$0.49^{a}\pm0.01$	$0.35^{ab}\pm0.01$	$0.42^{a}\pm0.01$	$0.16^{b}\pm0.01$
NM	$180.56^{a}\pm10.35$	$142.6^{ab}\pm9.62$	$153.30^{a}\pm10.56$	$78.62^{b}\pm5.65$

Means with the same letters along the rows are not significantly different ($p>0.05$)

Table 3: Body composition of *C. gariepinus* carcasses before and after exposed to sub-lethal concentration of 2, 4-D

		Final composition (% dry weight)			
Component composition	Initial	0.00	2.89	3.62	4.83
Dry matter	28.62	$26.82^{a}\pm3.61$	$20.06^{b}\pm3.12$	$17.66^{c}\pm2.22$	$14.16^{d}\pm2.13$
Ash	22.24	$20.76^{a}\pm3.26$	$10.17^{b}\pm2.13$	$19.68^{c}\pm2.54$	$19.22^{d}\pm2.56$
Ether extra	38.42	$37.26^{a}\pm4.02$	$29.68^{b}\pm3.52$	$26.32^{b}\pm3.51$	$22.24^{d}\pm3.12$
Crude fiber	06.24	$4.62^{a}\pm1.03$	$4.24^{b}\pm1.02$	$2.58^{b}\pm1.05$	$1.86^{d}\pm0.02$
Crude protein	86.54	$88.45^{a}\pm7.26$	$78.14^{b}\pm5.23$	$75.54^{c}\pm5.12$	$72.74^{d}\pm5.11$

Means with the same letters along the rows are not significantly different ($p>0.05$)

Table 3 shows the chemical analysis of *Clarias gariepinus* carcass before and after exposure. The percentage crude protein and oil content in the control fish after the experiment were significantly higher ($p<0.05$) than in the exposed groups. Crude protein and oil composition decreaseed with increasing concentration of the toxicant, while ash and Dry Matter (DM) increased.

DISCUSSION

Growth rate of the control fish was higher than those exposed to the toxicants. This may be due to lower feeding rate and or the toxicant made the feed unsuitable for consumption. It could also be due to an increased expenditure of energy on chemical detoxification and tissue repair. It is likely that marked reduction of growth rate of *C. gariepinus* in this study could be due to increase in metabolic activities and excretion of toxicant by the fish, thereby making more energy available for homeostatic maintenance than storage. Yaji (2006) observed a reduction of weight in *C. gariepinus* exposed to monocrotophos.

The suppressive effect on food consumption due to the toxicant may have contributed to poor nutrient utilization and body composition of *C. gariepinus*. The extent to which nutrients, particularly protein are utilized by fish is regulated by an interplay of dietary and environmental factors. In this study, the rate of FCR was low in the control and high in the highest concentration. This indicating that most of the feed were consumed and converted to flesh in the control, while there was reduction of feeding rate in fish exposed to the various 2, 4-D concentrations.

The significant decrease in the crude protein, dry matter and fat content of fish after 8 weeks exposure to 2, 4-D tend to suggest that the fish were severely stressed.

This study shows that exposure of *Clarias gariepinus* to low concentration of 2,4-D affects the physiology of the fish which over time affected the food acceptability and loss in weight. Therefore, it is dangerous to use this herbicide close to body of water used for fish production.

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