Acute Toxicity And Behavioural Changes On *African Catfish (Clarias gariepinus*) Exposed To Dizensate (Glyphosate Herbicide)

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ABSTRACT: The acute toxicity of Dizensate Glyphosate (N-phosphonomethyl glycine) to *Clarias gariepinus* adult was conducted using static bioassay under laboratory conditions. The four days median lethal concentration (96 hours LC_{50}) was determined as 43.65mg/l. Mean mortality was 0, 17, 33, 50 and 83% in the concentration of 19.2, 28.8, 38.4, 48.0 and 57.6mg/l respectively, while there was no mortality in the control treatment. There were significant differences ($P<0.05$) on the effect of concentrations on the fish. Fish response to the toxicant include erratic movement, air gulping, loss of reflex, molting, barbell deformation and excessive mucus secretion. Mortality increased with increase in concentration of Dizensate glyphosate and time of exposure. The physicochemical parameters also showed a slight increase as the concentration increased. It could be concluded that Dizensate glyphosate; an aquatic herbicide, has harmful effects on the behavioral, physiology and biochemistry of catfish which in turn affects the growth rate.

Keywords: acute toxicity, African catfish, Dizensate glyphosate, Herbicides, necrosis

INTRODUCTION

Most environmental problems of concern today are attributed to the production and release of toxic chemicals which are not only capable of interacting with the environment but also disrupting the ecosystem. Indiscriminate discharge of herbicides from agricultural run-off and other sources into aquatic media affects non target organisms such as fish and prawn which are of great economic importance to humans. Toxicants contaminate freshwater bodies and affect non-target organisms. Various researchers have reported on the effects of chemicals on aquatic organisms [1].

The impact of chemical environmental contamination on fish health, consequently fish productivity is of economical relevance for fishes as well as aquaculture. Environmental pollutants have been reported to accumulate in fish [2] and have threatened human health either directly or indirectly through the food chain. Accumulations of toxic compounds which may be carcinogenic or mutagenic were manifested as hazards [3]. However, the proper handling and use of herbicides in aquatic areas are especially critical, accidental spills or over dose can kill fish or cause other damage to its habitats that may lead to reduction in the fish population.

Environmental factors such as pH, turbidity, alkalinity, dissolved oxygen, temperature and conductivity influence the rate of reaction of the pollutants entering the water or the lethal effects on the aquatic organisms [4].

This study determines the 96h LC_{50} of glyphosate herbicide to adult of *C. gariepinus* and reports the effects on the physiology and survival of fish.

MATERIALS AND METHODS

Clarias gariepinus adults (mean wt., 215g) were acclimatized in glass tanks for 72 hours prior to the commencement of the study. The amount of herbicide which contained the require miligram of Dizensate herbicide was determined from the 480 g/L of Dizensate herbicide formulation and concentration of 9.6mg/l, 14.4mg/l, 19.2mg/l, 21.6mg/l and 24mg/l were introduced into each of the tanks in duplicate treatments and 0.0 mg/l (control).The fish were distributed randomly in duplicate treatments into 12 glass tanks (12 fish/tank). The pH of the solutions was measured with the pH meter, temperature with mercury-in-glass thermometer and dissolved oxygen with a digital DO_2/CO_2 meter. The exposure lasted for 96hours. Water temperature, pH and dissolved oxygen were determined every hour for the first four hours and once every four hour for the next twenty hours and once every twenty-four hours before the end of the experiment.

The LC_{50} was determined graphically using logarithm transformation at the end of the exposure period. All data obtained were subjected to Analysis of Variance (ANOVA) and multiple range test using the SAS. This investigations were conducted in accordance with the Guide for the Care and Use of Agricultural Animals in Agricultural Research and Teaching, published by the Consortium for Developing a Guide for the Care and Use of Agricultural Animals in Agricultural Research and Teaching, First Edition, 1988; the National Research Council (NRC) publication Guide for Care and Use of Laboratory Animals (copyright 2010, National Academy of Science).

RESULTS: The concentration of Dizensate herbicide that will bring about 50% mortality of the test organism in 96 hours is refered to as 96-h LC_{50}. The 96-h LC_{50} of Dizensate herbicide to fingerlings of C. gariepinus is presented in

Table 1. This value (43.65mg/l) is the concentrations of the treatments required to bring about 50% mortality of C. gariepinus fingerlings within 96 hours period. The acute toxicity of Dizensate herbicide decrease with increase in time.

The fish exposed to the Dizensate herbicide solutions showed erratic swimming, loss of reflex, peeling of the skin, discolouration, behavioural changes and increasing opercula ventilation and movement (Table 2).

The observation is confirmed by the significantly different mortality rates obtained due to dosage, according to Aguigwo [5]. The mortality pattern recorded corroborates with that reported by Rand and Pectrocelli [6]which stated that there should be less than 35% mortality in one of the concentration and at least more than 65% mortality in the highest concentration. The abnormal rapid movements of the fish subjected to high concentrations of Dizensate herbicide suggest that it acted on the nerves of the fish similarly reported by Okon [7]of pesticides.

Water quality attributes are prime factors that influence fish survival, reproduction, growth performance, and overall biological production (King, [8]; king and Jonathan [9]). They affect aquatic biotic integrity by directly causing mortality and / or shifting the equilibrium among species due to subtle influences such as reduced reproductive rates or alternations in competitive ability. This inverse relationship is interesting and indicative of higher demand for oxygen prompted by condition of hyperactivity as observed and explained by Ofojekwu et al., [10]and Oti [11]

Physicochemical parameter measured (Table 3) seemed to be within optimum range for fish culture as reported by Omitoyin et al. [12]and Olaifa et al. [13].There was a significant negative correlation between pH and dissolved oxygen values. There was a significant change in water quality resulting from increase in concentration of toxicant. This observation was in line with Okoli-Anunobi *et al*. [14]who investigated the lethal effect of the elephant Blue detergent (R) on the Nile Tilapia *Oreochronis niloticus*. In case of dissolved oxygen, the treatments did not only show a dose dependent decline in concentration, but also rapid depletion of dissolved oxygen with time. Warren [15]had earlier reported that the introduction of a toxicant into an aquatic system might decrease the dissolved oxygen concentration, which will impair respiration leading to asphyxiation. This was probably why the fishes were stressed progressively with time before death. Okoli-Anunobi *et al*. [14]also reported pH shift slightly from 6.30 to the alkaline death point of 10.75. This finding agrees with pH values in the present study.

Water qualities were also affected negatively in the exposed medium. This increase with increase in concentration of the toxicant. This will invariably affect the optimum growth and development of the cultured fish. Bacterials and other germs will thrive with bad water quality. Dissolved oxygen was noticed to decline with increase of the toxicant, a situation refers to as oxygen sag which is characterized by high mortality within short time. Death recorded could therefore have occurred by this reason.

DISCUSSION

The study was carried out to determine the toxicity of dizensate herbicide to the most cultivable fish specie in Nigeria, African catfish *Clarias gariepinus*. This test animal is important in capture and culture fisheries. Dizensate herbicide is toxic to *Clarias gariepinus.* This was revealed by the results of various investigation carried out in this study: the relatively very high values of LC_{50}; the abnormal behavior displayed in the exposed fish as well as various degenerative changes observed in the water parameters are pointer to this. It is time that the widespread use of this toxic chemical on ponds area, water ways, drains, streams, roadsides, footpaths, parks, gardens, schools, farms, forestry, national parks etc is stopped or highly restricted.

Table 1: Table shows the lethal concentrations (96-h LC_{50}) value of Dizensate herbicide to C. gariepinus adult after several hours.

TIME (Hours)	Log C value	LC_{50}
24	1.755	56.89mg/l
48	1.716	52.00mg/l
72	1.707	50.93mg/l
96	1.640	43.65mg/l

Key: LC50=Lethal Concentrations
Source: Field survey, 2011

Table 2: Behavioral changes observed on *Clarias gariepinus* during 96h exposure to Dizensate herbicide

Exposure Time	24hrs	48hrs	72hrs	96hrs
CONC.(mg/l)	0,19.2,28.8,38.4,48,57.6	0,19.2,28.8,38.4,48,57.6	0,19.2,28.8,38.4,48,57.6	0,19.2,28.8,38.4,48,57.6
BEHAVIOR				
Loss of reflex	- - - - - - - - - - + +	- - - + + +	- - + + + +	
Moulting	- - - - - - - - - - - +	- - - - + +	- - - + + +	

Discolouration	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Air gulping	-	+	+	+	+	+	-	+	+	+	+	+	-	+	+	-	+	+	-	+	+	+	+	+
Erratic Swimming	-	-	-	-	+	+	-	-	-	+	+	+	-	+	-	+	+	+	-	+	+	+	+	+
Barbel Deformation	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	+	-	-	+	+	+	+
Excessive Mucus Secretion	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+

Key : - = Not present
+ = Present
Source: Field survey, 2011

Table 3:Physico-chemical parameters measured during the 96h exposure to Dizensate herbicide (Mean ± S.D)

TIME	PARAMETERS	0 mg/l	19.2mg/l	28.8mg/l	38.4mg/l	48.0mg/l	57.6mg/l
Before	Temp (^{0}C)	25±0.1	25±0.2	25±0.1	25±0.1	25±0.1	25±0.2
	Ph	6.9±0.2	7.0±0.2	7.0±0.2	7.0±0.2	7.2±0.2	7.2±0.2
	DO_2 (mg/l)	5.9±0.1	5.8±0.1	5.8±0.1	5.8±0.2	5.9±0.1	5.8±0.1
1hr	Temp (^{0}C)	25±0.1	25±0.1	25±0.1	25±0.1	26±0.2	26±0.1
	Ph	7.0±0.2	7.0±0.2	7.0±0.2	7.0±0.2	7.2±0.2	7.2±0.2
	DO_2 (mg/l)	5.9±0.1	5.9±0.1	5.9±0.1	5.9±0.2	5.8±0.1	5.8±0.2
2hr	Temp (^{0}C)	25±0.2	25±0.2	25±0.1	25±0.1	26±0.1	26±0.1
	Ph	7.0±0.2	7.0±0.1	7.0±0.2	7.0±0.2	7.2±0.1	7.2±0.1
	DO_2 (mg/l)	5.9±0.1	5.9±0.1	5.9±0.1	5.8±0.1	5.9±0.1	5.9±0.1
3hr	Temp (^{0}C)	25±0.1	25±0.1	25±0.1	25±0.1	27±0.1	26±0.2
	Ph	7.2±0.2	7.1±0.1	7.1±0.1	7.1±0.1	7.2±0.2	7.2±0.2
	DO_2 (mg/l)	5.9±0.1	5.9±0.1	5.9±0.2	5.8±0.2	5.9±0.1	5.9±0.1
4hr	Temp (^{0}C)	26±0.2	27±0.2	27±0.1	27±0.1	27±0.1	27±0.1
	Ph	7.2±0.1	7.2±0.2	7.2±0.2	7.2±0.2	6.9±0.1	6.9±0.1
	DO_2 (mg/l)	5.9±0.1	5.9±0.1	5.9±0.1	5.8±0.1	5.7±0.1	5.8±0.1
8hrs	Temp (^{0}C)	25±0.1	27±0.2	27±0.2	27±0.2	27±0.1	27±0.1
	Ph	7.2±0.2	7.2±0.1	7.2±0.1	7.2±0.1	6.8±0.1	6.9±0.1
	DO_2 (mg/l)	5.8±0.1	5.9±0.1	5.8±0.2	5.8±0.2	5.7±0.1	5.7±0.1
12hrs	Temp (^{0}C)	26±0.2	26±0.1	26±0.2	26±0.2	27±0.1	27±0.2
	Ph	7.0±0.2	7.2±0.2	7.2±0.1	7.2±0.1	6.8±0.2	6.8±0.2
	DO_2 (mg/l)	5.8±0.1	5.9±0.1	5.9±0.2	5.8±0.2	5.7±0.1	5.7±0.1
16hrs	Temp (^{0}C)	25±0.1	25±0.1	25±0.2	25±0.2	28±0.1	28±0.1
	Ph	7.0±0.2	7.2±0.2	7.2±0.1	7.2±0.1	6.9±0.2	6.7±0.2
	DO_2 (mg/l)	5.8±0.1	5.9±0.1	5.9±0.1	5.7±0.1	5.7±0.1	5.6±0.1
20hrs	Temp (^{0}C)	25±0.1	25±0.2	25±0.2	25±0.2	28±0.2	28±0.2
	Ph	7.0±0.1	7.2±0.1	7.2±0.1	7.2±0.1	6.8±0.1	6.8±0.1
	DO_2 (mg/l)	5.7±0.2	5.7±0.1	5.6±0.2	5.5±0.2	5.6±0.2	5.6±0.1
24hrs	Temp (^{0}C)	27±0.0	27±0.1	27±0.1	27±0.1	28±0.2	27±0.1
	Ph	7.2±0.0	7.2±0.1	7.2±0.2	7.2±0.1	6.8±0.1	6.8±0.1
	DO_2 (mg/l)	5.7±0.2	5.5±0.1	5.9±0.1	5.5±0.1	5.3±0.1	5.3±0.1
48hrs	Temp (^{0}C)	27±0.1	27±0.2	27±0.2	27±0.2	29±0.2	28±0.2
	Ph	7.2±0.3	6.8±0.1	6.8±0.1	6.8±0.1	6.5±0.2	6.5±0.2

	DO_2 (mg/l)	5.6±0.1	5.5±0.1	5.9±0.1	5.5±0.2	5.2±0.1	5.2±0.1
72hrs	Temp (0^oC)	27±0.1	27±0.1	27±0.1	27±0.1	27±0.2	27±0.2
	Ph	7.2±0.1	7.2±0.2	7.2±0.2	6.9±0.2	6.6±0.1	6.4±0.1
	DO_2 (mg/l)	5.5±0.1	5.5±0.1	5.4±0.1	5.3±0.1	4.9±0.1	4.9±0.2
96hrs	Temp (0^oC)	27±0.2	27±0.1	27±0.1	27±0.1	27±0.2	27±0.2
	Ph	7.2±0.1	7.2±0.2	7.2±0.2	7.2±0.2	6.4±0.2	6.1±0.1
	DO_2 (mg/l)	5.4±0.1	5.4±0.1	5.7±0.1	5.3±0.1	4.4±0.1	4.4±0.1

Source: Field survey, 2011

Table 4: Estimation of the Log C and the LC_{50} value of Adult Catfish *Clarias garienpinus* exposure to dizensate for 96 hours.

Conc. (mg/l)	Log $_{10}$ Conc.	Total No	No. Dead	% Mortality	Corrected % mortality	Probit
T0 = 0	-	12	0	0	-	-
T1 = 19.2	1.283	12	0	0	-	-
T2 = 28.8	1.460	12	2	17	-	4.05
T3 = 38.4	1.584	12	4	33	-	4.56
T4 = 48.0	1.681	12	6	50	-	5.00
T5 = 57.6	1.760	12	10	83	-	5.95

Source: Field survey, 2011

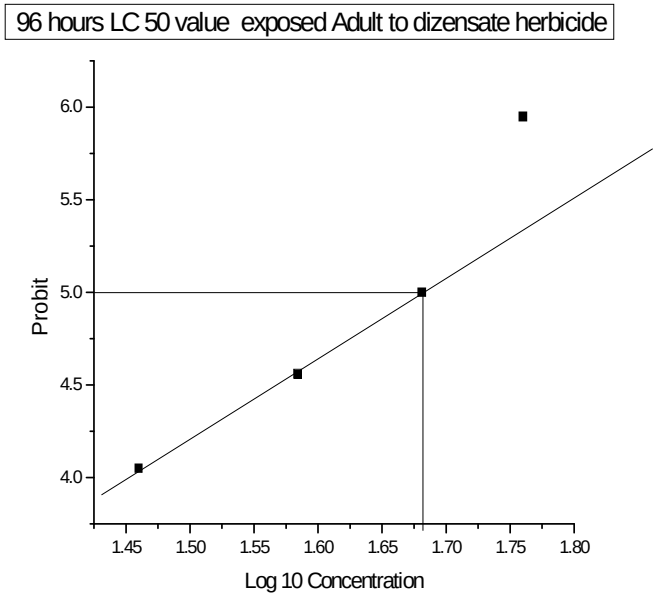

Fig.1 : Shows the LC_{50} for Adult of C. gariepinus at 96h exposure to Dizensate Herbicide

Source: Field survey, 2011

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