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Research Article

# Acute Pesticide Toxicity on *Oreochromis Niloticus*, with Particular Reference to Insecticides

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## Abstract

Pyriforce 600 EC and Cyperplant 100 EC are insecticides used in large quantities in agricultural practices in Cameroon. Residues due to intensive agriculture combined with surface runoff and surface drainage, a few weeks after application are deposited in water courses like ponds, rivers and lakes. This has negative effects on fish and other aquatic organisms which are of great concern to the wider public. To assess the risks of toxicity and their negative influence on aquatic biodiversity, acute toxicity bioassays on individuals of *Oreochromis niloticus* were carried out using Pyriforce 600 EC and Cyperplant 100 EC (toxicants) separately with nine concentrations in static media in aquariums for 24 hours. The test solution (P) representing the farmer's dose was prepared using each toxicant. For Pyriforce 600 EC, P was of 3.125 ml/l while for Cyperplant 100 EC P was 1.33 ml/l. From this test solution (P), different concentrations were calculated and introduced into various aquaria to which *Oreochromis niloticus* fingerlings were exposed. The nominal test concentrations for Pyriforce were: 0.0 µl/l, 2.60 µl/l, 3.125 µl/l, 3.9 µl/l, 5, 2 µl/l, 7.8 µl/l, 15.6 µl/l, 31.25 µl/l, 39 µl/l and Cyperplant were: 0.0 µl/l, 1.10 µl/l, 1.33 µl/l, 1.66 µ/l, 2.22 µl/l, 3.33 µl/l, 6.66 µl/l, 13.33 µl/l, 16.60 µl/l respectively. The experimental setup constituted of ten specimens, (3,5 ± 0,5) cm standard length and mean weight (2,75 ±0.5) g placed in each 75 ×45 cm glass aquarium located indoors, each containing 10 L of combined water from the pond from which test specimens were harvested and the test solution. Physicochemical parameters were measured throughout the test period following the recommendations of Rodier et al. Minimum (30±0.00%) and maximum (100 ±0.00%) mortalities were recorded. Correlations were positive and strong between mortality rates and concentrations. Physicochemical parameters did not vary greatly during the test period. The 50% lethal concentration for 24 hours of exposure (LC50-24 h) was relatively high with Cyperplant 100 EC (P/800) and low with Pyriforce 600 EC (P/1200) which turns out to be the most toxic pesticide. The results showed that they may cause serious long term effects in our ecosystem such as the killing of *Oreochromis nioticus* fingerlings even at very low doses which may lead to gross drop in their population in the ecosystem and even the extinction of the species if the situation is not controlled.

## Keywords

Pyriforce 600 EC, Cyperplant 100 EC, Toxicity, CL50-24 h, *Oreochromis Niloticus*

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# 1. Introduction

The modernization of agricultural practices has led to an increased use of modern synthetic pesticides [1]. A pesticide is any substance or mixture of substances of chemical or biological ingredients intended for repelling, destroying, or controlling any pest or regulating plant growth [2]. Farmers are growing high yielding cultivars of different crops to meet the increasing demand of food. But one important phenomenon of these high yielding varieties is that most of them are highly susceptible to pests and diseases [3], which may cause about 40% crop loss [4]. As a response to fight these pests, farmers use pesticides extensively to protect crops, herewith improving the yield quality as well as quantity [5]. There are currently about 769 pesticides registered (homologated) in Cameroon to control pests on crops, woods and for public health uses. These pesticides can be classified based on the pest they control; insecticides (insect control), herbicides (weed control), and fungicides (Mycotic control), or on the chemical class; organochlorines, pyrethroids, organophosphates. In spite of the positive trend in increased food production and improved health from the use of pesticides, the uses and misuses of these pesticides can have a significant impact on environmental pollution, and finally end up in foodstuffs [6]. Some pesticides are even known to be highly toxic to non-target organisms [7]. For aquatic ecosystems, it may have negative effects on fish and other aquatic life inhabiting ponds, lakes, rivers, streams and other similar water bodies which are of great concern to the wider public. This is because, residues due to intensive agriculture combine with surface runoff and surface drainage, a few weeks after application and are deposited in watercourses. These residues resulting from the inappropriate use of pesticides are however one of the most important food safety concerns.

Once pesticides residues reach aquatic ecosystems, they remain in these ecosystems through trophic transfers [8]. Some are consumed alongside food particles and are bio-accumulated in the tissues of aquatic organisms like fish. Many communities living along rivers and lakes depend on fishing as a source of livelihood. They harvest fishes and crustaceans and consume them [9]. This has public health implications because some of the bioaccumulated chemicals have carcinogenic and mutagenic effects [10]. Their effects on aquatic organisms are measured by carrying out toxicity tests. Our present study therefore aims at assessing the dose-response of *Oreochromis niloticus* to different concentrations of the two (2) most used insecticides in some agricultural zones of the center region and to determine the CL50 of these insecticides on *Oreochromis niloticus*. *Oreochromis niloticus* was chosen for the study because it is abundant in fresh waters and widely utilized in aquaculture because of its hardy nature. Moreover, *Oreochromis niloticus* is one of the most cultivated species in Cameroon among others. The main objective is to evaluate the acute pesticide toxicity on *Oreochromis niloticus* with particular reference to insecticides. Specifically, it is 1) to make an inventory of insecticides used in some agricultural zones of the center region Cameroon. 2) To analyze the physicochemical properties of certain fresh water ecosystems (ponds) and the impact of pesticides on them. 3) To determine the acute toxicity of the two most used insecticides on *Oreochromis niloticus*.

# 2. Materials and Methods

## 2.1. Study Area

The study was carried out in three phases in March 2021 and August 2021, in three main parts of the Center region of Cameroon namely Awae, Ebebda and Nkolbisson. The first phase was devoted to prospection, the second phase consisted of carrying out a survey to find out the various insecticides used by farmers in some agricultural zones in the center region. Lastly, the third phase consisted of carrying out toxicity tests on *Oreochromis niloticus* using two most used insecticides censured on the field, and the evaluation of some physicochemical properties of water used both on the field and in various aquaria throughout the test period.

Awae is situated in Mefou and Afamba, Center, Cameroon. Its geographical coordinates are 3°50' 0" North, 11°33' 0" East. Latitude 3.36667, longitude 11.8167 with an altitude of 568 m. Ebebda is situated in Lekie, Center, Cameroon. Its geographical coordinates are 4°21' 0" North, 11°16' 0" East. Latitude 4.33944, longitude 11.2839 with an altitude of 419 m. Nkolbison is situated in Mfoundi (Yaounde), Center, Cameroon. Its geographical coordinates are 3°27' 0" North, 11°27' 0" East. Latitude 3.85, longitude 11.6167 with an altitude of 695 m (Figure 1).

## 2.2. Determination of the List of Insecticides Used in Some Agricultural Zones in the Center Region

We carried out a survey to investigate the insecticides used by farmers in Awae, Ebebeda and Nkolbisson. The survey method was explored based on a semi-structured questionnaire and a checklist. The questionnaire was made up of four (4) parts: the first part made of closed-ended questions focused on the farmer's personal information; the second part focused on the farmer's knowledge on insecticide use; the third part focused on open-ended questions to eventually gain salient information in the identification of problems faced by farmers and proposed feasible solution undertaken; finally, the fourth part was on the state of insecticide use and the supporting NGOs if any. One hundred (100) farmers were randomly selected in the three (3) agricultural zones, and the "snowball" strategy was followed. This strategy enabled us to have 50 other farmers. A total of one hundred (100) questionaires was given for the farmers to fill.

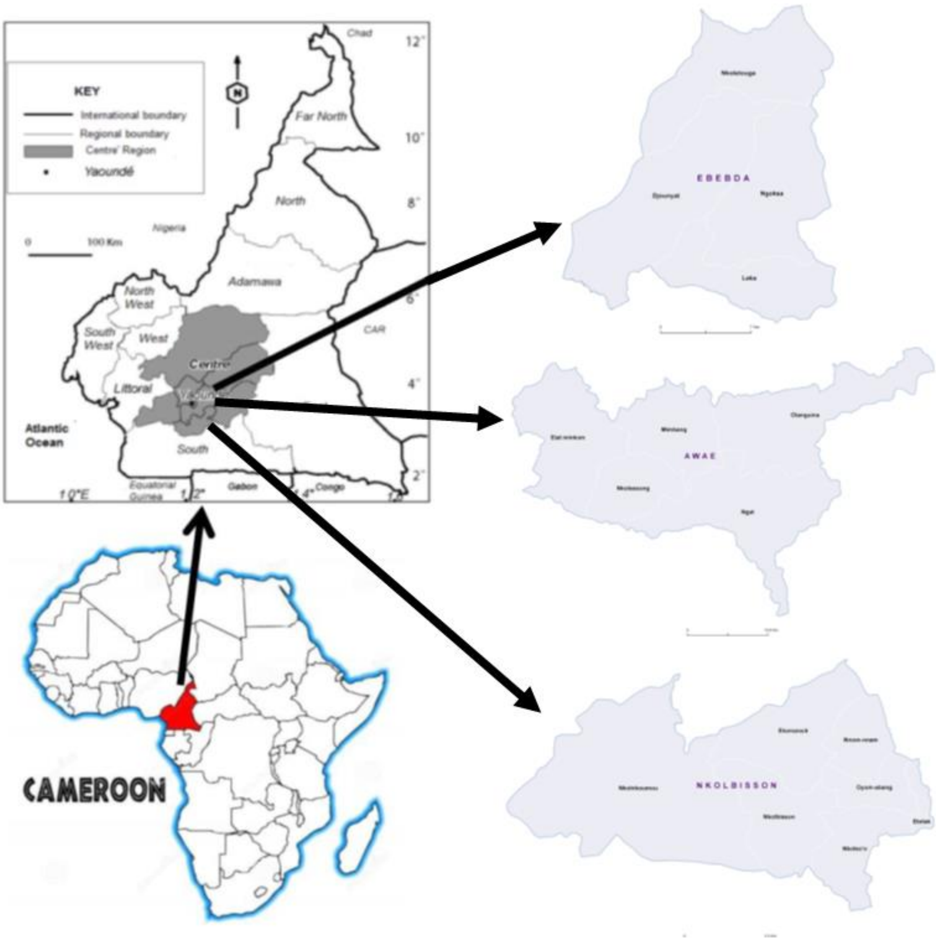



*Figure 1. Map showing Awae, Ebebda and Nkolbisson. (Source: own elaboration).*

## 2.3. Measurement of Environmental Variables

Physicochemical parameters were measured twice on the field. In the laboratory, measurements were done every one hour during the bioassay; from the moment different concentrations of insecticides were introduced in each aquarium following the recommendations of [11]. The parameters temperature, pH, electrical conductivity andtotal dissolved solids were measured using an EXTECH EC500 brand portable multi-parameter. The dissolved oxygen was measured using a multiparameter (HACH Hi 99300). The oxidability, dissolved carbondioxide, nitrites, nitrates, ammonium, phosphates, turbidity and Suspended solids were measured following the recommendation of [11, 12] standard methods.

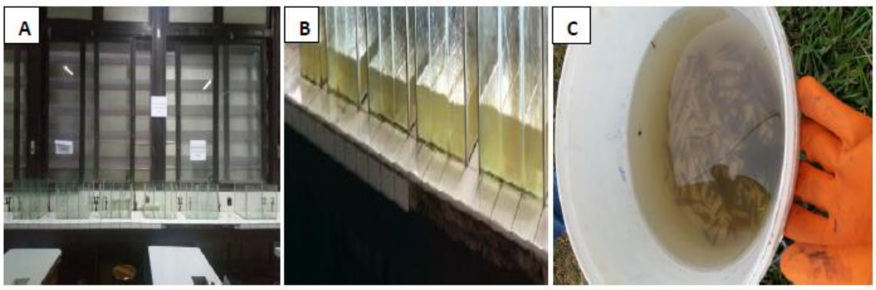



*Figure 2. A: Experimental set-up made of glass aquaria, B: glass aquaria containing source water; C: Oreochromis niloticus fingerlings in a bucket.*

### 2.4. Acute Toxicity Tests with Pyriforce 600 EC and Cyperplant 100 EC

The tests were performed in a laboratory equipped with glass aquaria labeled $A_0$ to $A_8$. The aquaria were washed with diluted alcohol, rinsed with distilled water and then sundried to avoid fungal contamination (Figure 2A). The indoor aquaria were each filled with 10 liters of water from a pond from which test specimens were harvested (Figure 2B). About 600 healthy active fingerlings ranging between (3.5 ±0.5) cm standard length and of weight (2.75 ±0.5) g were transported to the laboratory from the Obili fish farm about 1 km away (figure 2C).

#### 2.4.1. Fish Acclimatization

The specimens were acclimatized to laboratory conditions for 1 day in indoor glass aquaria. The pH, dissolved oxygen concentration, temperature, conductivity, Total Dissolved Solids, and salinity of water in the aquaria were measured using a standardized digital multiparameter. The specimens were not fed.

#### 2.4.2. Acute Toxicity Test

Toxicity tests were conducted in accordance with standard methods [12]. A stock solution of Pyriforce 600 EC (Figure 3A), with a concentration of 3.125 ml per litre (Farmer's dose, P) was prepared in distilled water and the desired degree of concentrations was prepared as follows; P/1200, P/1000, P/800, P/600, P/400, P/200, P/100, P/80. The stock solution of Cyperplant 100 EC (Figure 3B), with a concentration of 1.33 ml per liter (Farmer's dose, P) was also prepared in distilled water and different dilutions were prepared by adding required amount of distilled water. The desired degree of concentrations was equally prepared as follows P/1200, P/1000, P/800, P/600, P/400, P/200, P/100, and P/80. Preliminary tests were conducted to provide guidance on range of concentration of insecticide to use in the bioassay. The specimens were not fed during toxicity tests to reduce faecal and excess food contaminating the test solution. The nominal test concentrations for Pyriforce and Cyperplant were; 0.0 µl/l, 2.60 µl/l, 3.125 µl/l, 3.9 µl/l, 5,2 µ/l, 7.8 µl/l,15.6 µl/l, 31.25 µ/l, 39 µl/l and 0.0 µl/l, 1.10 µl/l, 1.33 µl/l, 1.66 µ/l, 2.22 µl/l,3.33 µl/l, 6.66 µ/l, 13.33 µl/l,16.60 µl/l respectively. Ten specimens were placed in each 75 × 45 cm glass aquarium located indoors, each containing a test solution and 10 L of water from the pond from which test specimens were harvested. The behaviour of specimens was observed and death was recorded for the 24 h test period. Death was defined as complete immobility with no flexion of the abdomen upon forced extensions. The duration of the test was 24 hours, with evaluations every one hour.

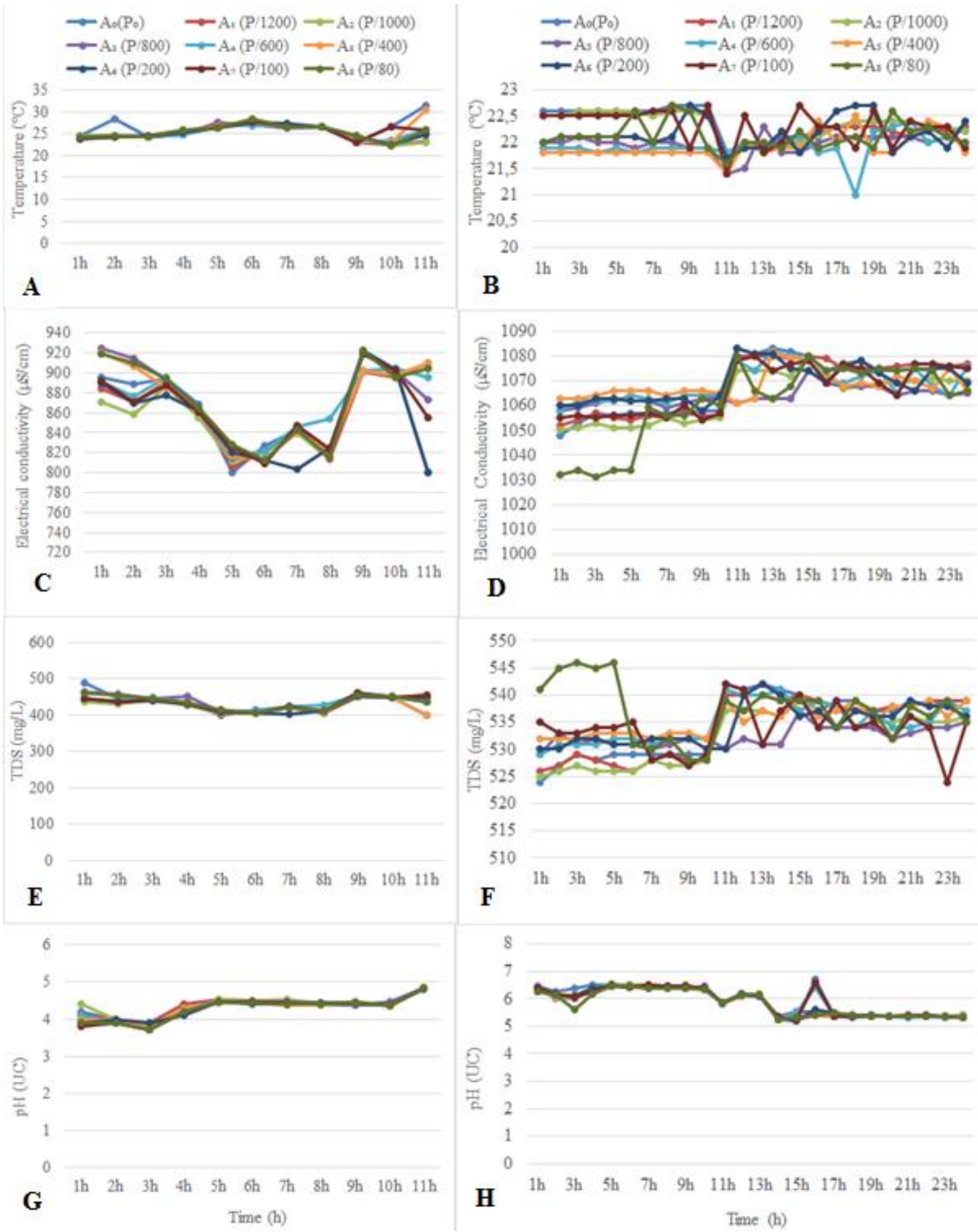

***Figure 3.*** *Stock solution of Pyriforce 480 EC (A) and Cyperplant 100 EC (B).*

### 2.5. Data Analysis

The data generated from questionnaires and physico-chemical parameters were analyzed using a template before applying descriptive statistics of frequency and percentage. Frequency distributions were computed and presented in tables and bar chart graphs. The data were analyzed using SPSS version 25.0. Acute toxicity with Pyriforce 600 EC and Cyperplant 100 EC on *Oreochromis niloticus* was estimated based on lethal concentrations causing 50% (CL 50) dead's in the population exposed. This CL 50 was analyzed with Probit from the EPA, version 1.3.

***Table 1.*** *Frequency distribution of insecticides used by farmers in Awae, Ebebeda and Nkolbisson.*

| Types of insecticides used | Frequency | Percent | Cumulative Percent | Crops on which it is used |
|---|---|---|---|---|
| PYRIFORCE 480 | 25 | 27.7 | 27.7 | Pineaple, cacao, tomatoes |
| CYPERPLANT 100 EC | 23 | 26.4 | 54.1 | Okra, tomatoes |
| LAMIDA GOLD 90 EC | 19 | 21.8 | 75.9 | *Lactiva sativa* (lettuce), *Solaniums crabum* (huckleberry) |
| LAMIDA GOLD 50 EC | 8 | 9.1 | 85.0 | Okra, tomatoes, cacao, pepper |
| CYPERPLANT 50 EC | 6 | 7.0 | 92.0 | Okra, tomatoes, cacao, pepper |
| MOCAP | 4 | 4.6 | 96.6 | Pineaple |
| LAMIDA GOLD 100 EC | 4 | 2.3 | 100.0 | Tomatoes, cacao, pepper |
| Total | 87 | 100.0 | | |




(AB: Temperature; CD: Electrical Conductivity; EF: TDS; GH: pH)

***Figure 4.*** *Physicochemical parameters variation in time in different aquaria during the test period with Pyriforce 480 EC and Cyperplant 100 EC.*

## 3. Results

### 3.1. Insecticides Used in Some Agricultural Zones in the Center Region

A total of seven different insecticides were found to be used by formers in the three agricultural zones (Table 1). These insecticides in descending order of frequency were; Pyriforce 600 EC (25), Cyperplant 100 EC (23), Lamida gold 90 EC (19), Lamida gold 50 EC (8), Cyperplant 50 EC (6), MOCAP (4), Lamida gold 100 EC (2) (Figure 4). The frequencies were expressed in percentage, and the crops on which each insecticide was used listed (Table 1).

### 3.2. Variation of Physicochemical Parameters of Water in Aquariums During the Test Period

Throughout the experiments, temperature varied just slightly in all the aquaria. With Pyriforce 600 EC the values fluctuated between 22.2 and 31.4℃. The highest value, 31.4℃ was recorded in aquarium $A_0$ ($P_0$) at the 11th hour. The lowest value, 22.2℃ was recorded in aquarium $A_2$ (P/1000) at the $10^{th}$ hour (Figure 4A). The average temperature was 25.3± 1.7℃. With Cyperplant 100 EC the values fluctuated between 21.4℃ and 22.7℃. The highest value, 22.7℃ was recorded in aquarium $A_0$ ($P_0$) at the 8th hour. The lowest value, 21.4℃ was recorded in aquarium $A_3$ (P/800) at the 11th hour (Figure 4B). The average temperature was 22.1±0.3℃.

The values of Electrical conductivity varied between 800 and 925 µS/cm with Pyriforce 600 EC and 1031 and 1083 µS/cm with Cyperplant 100 EC. With Pyriforce 600 EC the maximum value was 925 µS/cm while the lowest value was 800 µS/cm (Figure 4C). The average value was 865.1± 38.1 µS/cm. With Cyperplant 100 EC the maximum value was 1083 µS/cm while the lowest value was 1031 µS/cm (Figure 4D). The average value was 1066.5±10.0 µS/cm.

The values of TDS varied between 400 and 488 mg/L with Pyriforce 480 EC. The highest value, 488 mg/L was recorded in aquarium $A_0$ at the first hour. The lowest value, 400 mg/L was recorded in aquarium $A_5$ (P/400) and $A_0$ ($P_0$) at the $11^{th}$ hour (Figure 4E). The average TDS was 433 mg/L. With Cyperplant 100 EC the values fluctuated between 524 and 546 mg/L. The highest value was 546 mg/L while the lowest value was 524 mg/L (Figure 4F). The average TDS was 534.3±4,5 mg/L.

The pH values varied between 3.7 and 4.85 with Pyriforce 480 EC (Figure 4G) and 5.2 and 6.69 with Cyperplant 100 EC. With Pyriforce 600 EC the maximum value was 4, 85 while the minimum value was 3.7. The average value was 4.3149±0.2. With Cyperplant 100 EC the highest value was 6.69 while the lowest value was 5.2 (Figure 4H). The average value was 5.8± 0.4.

## 3.3. Physicochemical Parameters of the Control Experiments, Test Experiments Death and Number of Deaths by Day

### 3.3.1. With Pyriforce 600 EC and Cyperplant 100 EC

At the 11th hour of the experiment with Pyriforce 600 EC, the highest number of deaths in each aquarium was evaluated. The highest death was recorded in aquarium $A_8$. At the 11th and 24th hour of the experiment with Cyperplant 100 EC, the highest number of deaths in each aquarium were evaluated. The highest number of deaths was recorded in aquarium $A_8$, $A_2$ and $A_3$. The physicochemical parameters of the aquaria recording the highest death, the raw sample and the control experiment was equally evaluated (Table 2 and Table 3).

***Table 2.*** *Physicochemical parameters of the control experiments, test experiments with the highest death and the corresponding number of deaths at the 11th hour of experimentation.*

| Parameter | Raw sample | Control Experiment (No Dead) | Test Experiments with Highest N°of Deads |
|---|---|---|---|
| | | $11^{th}$ h | $11^{th}$ h |
| | | $A_0$ | $A_8$ |
| Temperature (℃) | 26.2 | 25.8 | 27.4 |
| Electrical Conductivity (µS/cm) | 369 | 368 | 365 |
| TDS (mg/L) | 175 | 175 | 173 |
| Suspended Solids (mg/L) | 27 | 27.5 | 27.8 |
| Turbidity (FTU) | 6 | 8 | 9 |
| Color (Pt-co) | 259 | 261.5 | 273 |
| Dissolved $CO_2$ (mg/L) | 4.9 | 5.17 | 8.79 |
| Dissolved $O_2$ (mg/L) | 6.34 | 5.31 | 3.69 |
| Oxydability (mg/L) | 9.88 | 8.3 | 7.03 |
| $NH_4^+$ (mg/L) | 0.22 | 0.79 | 1.23 |
| $NO_2^-$ (mg/L) | 0.01 | 0.05 | 0.04 |
| $NO_3^-$ (mg/L) | 0.012 | 0.014 | 0.045 |
| $PO_4^{3-}$(mg/L) | 0.08 | 0.10 | 0.20 |

*Table 3. Physicochemical parameters of the control experiments, test experiments with the highest dead's and the corresponding number of dead's at the 11th hour of experimentation.*

| | | Control Experiment (No Dead) | | Test Experiments with Highest N °of Deads | | |
|---|---|---|---|---|---|---|
| Parameter | Raw sample | 11$^{th}$ h | 24 $^{th}$ h | 11$^{th}$ h | 24 $^{th}$ h | |
| | | $A_0$ | $A_0$ | $A_8$ | $A_2$ | $A_3$ |
| Temperature (℃) | 26.2 | 26.3 | 26.2 | 26.6 | 25.9 | 26 |
| Electrical Conductivity (µS/cm) | 381 | 379 | 377 | 368 | 365 | 364 |
| TDS (mg/L) | 182 | 174 | 173 | 172 | 171 | 172 |
| Suspended Solids (mg/L) | 10 | 8 | 0 | 2 | 12 | 9 |
| Turbidity (FTU) | 15 | 1 | 20 | 3 | 18 | 15 |
| Color (Pt-co) | 61 | 8 | 102 | 11 | 106 | 87 |
| Dissolved $CO_2$ (mg/L) | 6.71 | 6.4 | 6.33 | 3.46 | 4.01 | 4.21 |
| Dissolved $O_2$ (mg/L) | 6.56 | 6.34 | 4.46 | 3.36 | 4.03 | 3.62 |
| Oxydability (mg/L) | 9.88 | 8.3 | 9.48 | 13.03 | 12.64 | 12.81 |
| $NH_4^+$ (mg/L) | 0.14 | 0.01 | 1.08 | 0.01 | 0.10 | 1.08 |
| $NO_2^-$ (mg/L) | 0.002 | 0.011 | 0.00 | 0.012 | 0.00 | 0.00 |
| $NO_3^-$ (mg/L) | 0.5 | 2.2 | 0.5 | 3.8 | 0.0 | 0.01 |
| $PO_4^{3-}$(mg/L) | 222 | 221 | 302 | 280 | 255 | 261 |

### 3.3.2. Acute Toxicity Tests Result with Pyriforce 600 EC and Cyperplant 100 EC

Upon administration of our toxicants (Pyriforce 600 EC and Cyperplant 100 EC) in the various aquaria, test fishes agitated, moving up and down, left and right but not as active as in the control experiment. As time elapsed, we recorded mortalities in test experiments. Mortalities were recorded earlier in higher concentration and increased with time (Figure 5 A and B). In the highest concentration, some test fishes moved up and allowed themselves to fall freely, others lied on their side while others fell to the bottom and in the course of trying to swim upward, hey fell back to the bottom. This continued until the fishes became completely immobile where they were recorded as dead. Pyriforce 600 EC caused 100% mortality of *Oreochromis niloticus* in all test experiments after 11 hours and LC50 P1/1200. The LC50 values obtained for the two pesticides revealed that Pyriforce showed higher toxicity than Cyperplant (Figure 5).

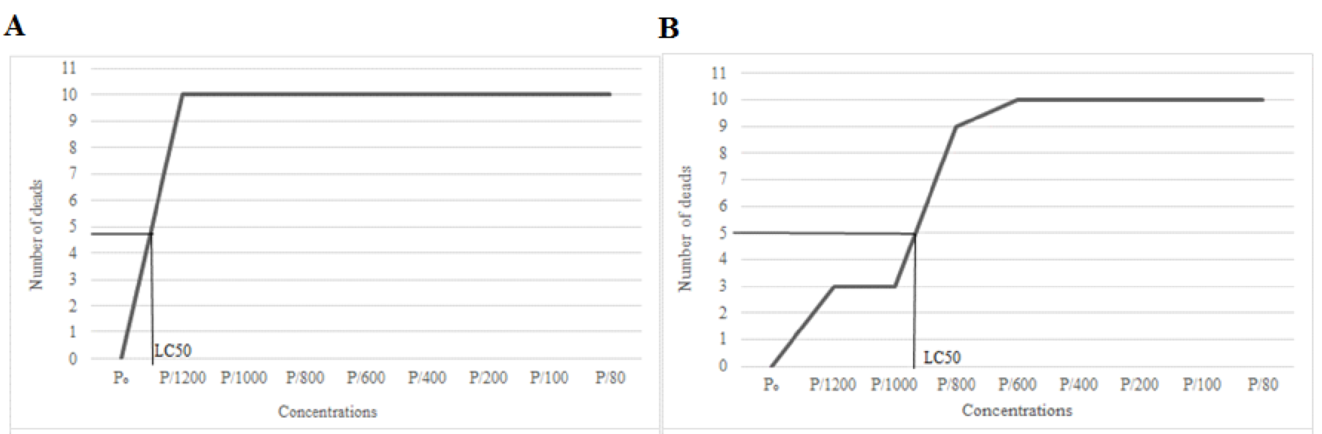



*Figure 5. Mortality of Oreochromis niloticus with time at different concentrations of Pyriforce 480 EC (A) and Cyperplant 100 EC (B).*

### 3.4. Relationship Between Physicochemical Parameters and Number of Deaths

On the basis of the statistical tests carried out, the interdependence links were proven and highlighted between some environmental parameters and number of death along the experiment. Note that no significant correlation was found during the experiments for Cyperplant 100 EC to the temperature and number of death. Thus, Electrical conductivity and TDS were negatively correlated to number of deaths (r = -0,298; p = 0,000; r = -0,149; p = 0,028) and pH positively correlated to number of deaths (r = 0,399; p = 0,000). As for Pyriforce 600 EC, we observed that temperature and pH were positively correlated to number of deaths (r = 0,210; p = 0,037; r = 0,243; p = 0,016). The number of dead fishes were negatively correlated to Electrical conductivity and TDS (r = -0,268; p = 0,007; r = -0,275; p = 0,006).

## 4. Discussion

The list of insecticides censored in Awae, Ebebda and Nkolbisson showed that farmers use a wide range of insecticides on crops. These farmers use these insecticides intensively to grow crops among which are cacao, tomatoes, pineaples, okra etc. Among many insecticides recorded on the field, Pyriforce 600 EC and Cyperplant 100 EC are the two most used insecticides used. All farmers censured in the above mentioned areas apply these insecticides on their crops frequently at doses equal to and for others above the dose prescribed on the user guide of the insecticides. The proximity of their farms to nearby water sources is a clear indication that runoff carrying residues of these insecticides are deposited in these water bodies and are taken alongside with food by aquatic organisms like *Oreohromis niloticus*. The farmers dose of Pyriforce 600 EC (P = 3.125 and Cyperplant 100 EC (P= 1.33) were far greater than the concentrations used in our experimentation in the laboratory. These laboratory concentrations which were diluted up to 1200 (P/1200) times induced mortalities in *Oreochromis niloticus* fingerlings. As soon as these fingerlings were exposed to Pyriforce 600 EC and Cyperplant 100 EC, they became less active depending on the concentration. In their natural environment such as in ponds or lakes, this will make them vulnerable to their predators and diseases unless they escape early enough. According to Finney's Probit Analysis Method the 24h LC50 value of Pyriforce 600 EC and Cyperplant 100 EC in *Oreochromis niloticus* were found to be P/1200 and P/1200 respectively in our work. These values were less than the farmer's dose, P 1.33 ml per litre and 3.125 ml per litre respectively. This shows that Pyriforce and Cyperplant are highly toxic to fish. A similar observation was made in previous studies using *Oreochromis mossambicus* in South Africa [13]. Our results are in agreement with those reported by [14, 15]. Most of the physicochemical parameters are not affected by Pyriforce 600 EC and Cyperplant 100E EC. These results corroborate those of [16] who found out that contamination by pesticide (endosulfan) does not significantly affect the physico-chemical parameters of the water in the medium studied. Nevertheless, apart from the control experiment there are other fingerlings in the test experiment with cyperplant 100 EC that did not die in the test solutions even after the 24 h; there is, however, a probability that they had accumulated some amount of toxins. When such fishes are consumed by man, implications may include respiratory malfunctions, hypersensitivity and genetic mutations. There are also problems that can arise as a result of mishandling and wrong applications of chemicals. Some have corrosive effects and produce a burning sensation when used without protective gloves [17]. It must not be forgotten, however, that agents of toxicity, only very exceptionally, possess selective toxicity toward their target organisms; they can exercise harmful effects on other categories of living creatures, particularly on man himself [18]. High values of chemicals in water bodies that serve as source of drinking water reduces its quality and can pose serious health problems such as diarrhea and vomiting. In the same vein, they are a potential risk to aquatic biodiversity. This is because, farmers apply these insecticides repeatedly on crops in farmlands and residues washed by runoff water are deposited in aquatic ecosystems. In these ecosystems they induce mortality on fingerlings as demonstrated by our work. The death of these fingerlings results to the decline in the population of adult fish on which humans and many other animals depend for food. Given that farmers use these insecticides repeatedly, it indicates a continuous contamination of these aquatic ecosystems and as a result the continuous death of fingerlings. This continuous death of fingerlings in a long run may lead to the extinction of *Oreochromis niloticus* in the affected ecosystem. Fish are particularly sensitive to contaminants. Indeed, [19] showed that the contamination of fish occurs through the large, fine branchial respiratory surfaces and that the toxic effects deriving there are added to those caused at the cellular and tissue levels. In addition to its inhibitory action on the absorption of $NA^+$ ions in the gills [20, 21], insecticides induce necrosis and apoptosis of endothelial and respiratory cells, increases the permeability of the epithelium (gill included) to water to certain ions and thus induces a systematic disorder leading to the deterioration of the gills [22]. *Oreochromis niloticus* is an economically important freshwater fish cultured in Cameroon but acute toxicity due to bioaccumulation of insecticides are very serious problems. These problems result to the death of fingerlings even at very small doses of the insecticide which directly enlightens us on the reasons for a continuous decline in the quantity of fresh water fish. This effect is equally proven by the continuous increase in the price of the fresh water fish in our markets and even the inadequate supply to satisfy the demand.

## 5. Conclusions

This study shows that under laboratory conditions, the organisms tested in this study are sensitive to Pyriforce 600 EC and Cyperplant 100 EC. The $LC_{50}$ values obtained for the organisms are far below the recommended doses for the treatment of plants, ie 3.125 ml per liter for Pyriforce 600 EC and 1.33 ml per liter for Cyperplant 100 EC. Low doses of Pyriforce 600 EC and Cyperplant 100 EC induce harmful effects on all the species tested. Therefore, their intensive and extensive application on crops should be controlled so as to avoid long term degradation of aquatic life. The toxicity of insecticides being evident on the fingerlings of *Oreochromis niloticus*, it is important to emphasize the following needs: -informing farmers about the risks associated with misuse, repeated and prolonged applications of Pyriforce 600 EC and Cyperplant 100 EC; -the integration of the results of studies carried out in the local context, in the criteria for the registration of pesticides in our country; -the constant control of the import, the frequency of use and the doses of application of insecticides for agricultural use; -Government should promote the use natural insecticides.

The conclusions of this study lead us to other themes of great importance, among others: -The evaluation of the effects of multiple applications of these insecticides under simulated field conditions, on edaphic and aquatic ecosystems. -Follow-up field studies in fields that receive constant applications of these insecticides, in order to assess the long-term effects of the latter. -The study of the bioconcentration of these insecticides in natural environments.

## Abbreviations

| | |
|---|---|
| CL | Lethal Concentration |
| EPA | Agency for Environmental Protection |
| SPSS | Statistical Package for Social Sciences |
| TDS | Solid Total Dissolved |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## Author Contributions

**Tuekam Kayo Raoul Polycarpe:** Conceived and designed the experiments; Contributed to the reagents; materials; data Analyzed and interpreted the data; Wrote the paper

**Nguemetia-Mogni Paul-Derrick:** Conceived and designed the experiments; Analyzed and interpreted the data; Wrote the paper

**Chinche Belengfe Sylvie**: Analyzed and interpreted the data; Wrote the paper

**Zebaze Togouet Serge Hubert:** Supervising work; Performed the experiments; final reading


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## Data Availability Statement

Data included in article/supp. material/referenced in article.

## Conflicts of Interest

The authors declare no conflicts of interests.

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